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PERSONAL IDENTIFICATION

METHODS FOR THE IDENTIFICATION OF INDIVIDUALS, LIVING OR DEAD

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TO

SIR EDWARD RICHARD HENRY

OF SCOTLAND YARD, WHOSE PRACTICAL SUCCESS IN THE INTRODUCTION OF THE SYSTEM OF FINGER-PRINT IDENTIFICATION, AS THE FIRST ABSOLUTELY POSITIVE METHOD OF IDENTIFYING THE INDIVIDUAL, DESERVES THE GRATITUDE · OF MANKIND ·

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PREFACE

THIS book is primarily intended to place before the general public a very live problem, and consider all the ways by which, up to the present time, a solution has been sought.

The problem is that of the Personal Identification of human individuals; the means by which a person, or a dead body, may be definitely recognized, even in cases where the person purposely attempts to mislead, or where a dead body is mutilated beyond ordinary means of recognition. It is plain that such an identification must rest upon certain individual bodily characters; and as such matters are scientifically dealt with by the physical anthropologists, it is to the specialists in this branch of science that we naturally turn for aid.

Up to the present the main use of such scientific methods of bodily identification has been confined to the identification of the criminal classes, whose practices render them notably elusive as to personality; yet there are countless other cases where the identification of individuals is equally necessary, and where the ordinary methods of recognition are insufficient. The liability to accidents involving the mutilation of the face, the frequency with which a man's mind may become temporarily or permanently beclouded, the temptation to fraud often felt by men who do not belong distinctly to the criminal class, attempts of impostors to claim estates; these and numerous other possibilities render some sure method of bodily identification one of the great necessities of civilization. Such a system would be of great value to families, insurance companies, banks, industrial institutions, and all great business enterprises involving responsibility for employees. The need is present in schools and hospitals, especially maternity hospitals, and those for the insane, while, in time of war, as at the present moment, comes the pressing need of adequately identifying all enlisted men, however numerous they may be. The need of individual identification is imperative, too, in the case of passports, railroad passes and all kinds of legal papers involving and bestowing special privileges which are non-transferable.

This problem of individual identification has thus passed already far beyond the walls of police stations and penitentiaries, and the demand is seen, more and more clearly, for some method of universal identification embracing all the citizens of the Nation. The science of individual identification through the various bodily peculiarities has now quite outgrown the prison walls, in which it was nurtured, and is ready to fill the place which the growing needs have made for it.

In this is seen the mission of the present book. It attempts to lay before the reader all known methods of personal identification, including, of course, the system of measurements inaugurated by M. Bertillon, and the now famous system of finger prints devised by Sir Francis Galton and put into actual use by Sir E. R. Henry. It also introduces two new methods, those based upon the friction-skin configuration of the palm of the hand and the sole of the foot, which, although their possibilities have been previously exploited in technical journals, appear here for the first time in practical form for general use.

In the case of the first-mentioned systems, bodily measurements and finger prints, the book makes no claim to furnish a complete working manual, but rather refers the reader to the original works of Bertillon, Galton, Henry, and the more recent American writers, Seymour, Kuhne, and Evans. In the part dealing with the finger-print system the book looks to the future rather than to the present, and contemplates certain practical reforms in the present system. It thus advocates an ideal system of finger-print formulation, while it explains in detail the system as now in use. By so doing this portion of the book (Part II, Chapter V) may serve to instruct a novice in the present system, while presenting at the same time a broad view of the subject upon which the system is based, and suggesting the endless possibilities for future improvement.

The two new systems of identification, (1) by the palms, and (2) by the soles, being presented here for the first time, are made sufficient for immediate application, and their treatment is adapted for self-instruction.

It is here our pleasant duty to record and acknowledge the encouragement and material assistance which the authors have received from colleagues and friends during the progress of this work. From Scotland Yard, London, and more especially from the Chief, Sir E. R. Henry, have been sent a number of illustrations and accompanying data, used mostly in Part II, Chapter VII; much of the material and illustrations for Part II, Chapter VIII, has in the same way been furnished by the Director of the Police Laboratory of Lyons, France, M. Edmond Locard.

To the Police Department of New York City, and especially to Commissioner Guy H. Scull, we are indebted for the details concerning the La Rosa case; also to the two Pacinis, father and son, for the details of the restoration made by the former. One of our most inspiring and zealous friends, who has constantly aided us in many ways, is the finger-print expert of the City Magistrates Court, Brooklyn, Mr. G. Tyler Mairs. Many of his suggestions are embodied in the text, or appear as footnotes over his initials, and his criticisms throughout have been of the greatest assistance to us. Mr. Albert S. Osborn, also, the handwriting expert, has shown us much personal kindness, and has been now for many years a stimulating correspondent; William M. Evans of the Bureau of Criminal

Identification, Chicago, Illinois, furnished the information and illustrations of the "Jennings" case, and M. W. McClaughry, special agent of the Department of Justice at Leavenworth, Kansas, furnished the illustrations and details of the case of William and Will West.

Many personal friends of the authors have taken a serious interest in the undertaking of this work, and have aided us greatly by their encouragement and interest. Among these may be mentioned Mr. R. C. Hill, now in charge of the State Bureau of Criminal Identification at Boston; the late Henry Richardson, formerly in charge of the same Bureau; Mr. G. Gustafson, at Police Headquarters, Pemberton Square, in the same city; City Marshal O. B. Fernandez, and the late City Marshal W. L. Avery, both of Old Town, Maine; Mr. Lee Seymour of Los Angeles, California; Mr. John Frank Platts and Mr. Byron J. Page of Dover, New Hampshire; and the leading promoter of the use of finger prints for bank identification, Ray E. Bauder of Taylorville, Illinois, has aided us by allowing the use of certain illustrations of his system.

It is finally to be remembered that, in advocating universal identification records, in advising the employment of the palms and soles in addition to the finger prints, and in presenting certain modifications of the systems now in use, the authors look toward the future rather than to the present only. The book is thus not primarily designed to give instruction to those wishing simply to learn the methods at present employed in our principal police departments, although these methods are quite fully dealt with, but rather to show the thinking public what the possibilities are of the various methods of identification, and especially those met with in the employment of the permanent, unvarying, and absolutely individual *friction ridges*, which cover the entire lower, or ventral, surface of the hands and feet.

Harris Hawthorne Wilder
Bert Wentworth

April 15, 1918

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PART I

Methods Which Furnish Partial Identification

PERSONAL IDENTIFICATION

CHAPTER I

THE PROBLEM

"And he causeth all, both small and great, rich and poor, free and bond, to receive a mark in their right hand, or in their foreheads; and that no man might buy or sell, save that he had the mark, or the name of the beast, or the number of his name." — Rev. XIII: 16, 17.

THROUGH our city streets pass and repass vehicles of all sorts, each bearing a license number, conspicuously displayed. As these numbers are all recorded at the place where each vehicle is owned, they furnish an easy means of identifying the individual vehicles.

The people that pass in a double current upon either side of this stream of traffic are not thus registered; they bear no identification number, and have a place in the commonwealth simply by virtue of a personal name, recorded at the time of birth, and held simply in the memory of the individual himself and of his personal acquaintances. Under numerous circumstances, some of them by no means rare, this loose system, relying as it does upon the individual memory, and the willingness to be identified, proves insufficient or actually misleading, and there is thus great need of a surer method of definitely describing and recording each human individual. This would seem to be possible under all circumstances only by making use of some mark or peculiarity permanently and unalterably fixed upon the body itself, and the best efforts of the anthropologists have now for many years been devoted to this question.

It will naturally be asked at the outset what are the circumstances under which the personal name and the aspect of the face and figure are not sufficient for identification, and the present connection of identification systems with criminals unfortunately causes most men to dismiss the whole matter as unimportant for honest men; yet the criminal side is but a small part of the whole question, and to one case involving a criminal there are a dozen in which the individual to be identified has committed no wrong, and where the question is purely a civil one.

One frequently needs to identify himself at a bank or business house; he must assert his claim to a given passport, or individual check or ticket, issued to himself alone; he must frequently prove himself the accredited

representative of a firm or corporation; and at the time of writing there has come up the great need of definitely recording each soldier and sailor at the time and place of recruiting. The method sought must, moreover, be one by which the body may be identified after life is extinct, or when the individual, though still alive, either cannot tell who he is, or refuses to do so. The method must be based upon such bodily characters that an identification may be definitely established upon bodies found on the field of battle, or floating in the sea, even after serious mutiliation.

Even apart from times of war, there are the numerous disasters by fire or flood, by railroad collision or explosion, in which the authorities have to deal with bodies often so badly disfigured that they cannot be recognized by ordinary means. To prevent such mistakes many men, on their own initiative, carry numbered "identification tags," issued by some society, bank, or other corporation, but the number of those thus safeguarded is still very small, and there are countless numbers of the "nameless dead" whose death can never be legally proven.

This frequent failure to identify often prevents the granting of a clear title to property, or may even result in the legal "death" of a man, whose subsequent return causes serious legal difficulties both to himself and others; it also allows the disappearance of a man who for some reason wishes thus to shirk certain responsibilities. It is often important to properly identify a body because of questions of inheritance, insurance, pension, or other matters that concern property, and the ease with which deception can be practiced with a disfigured body has given rise to many cases of fraud. In the case of great estates, and even of thrones, proof of the death of the heir, with a satisfactory identification of the body, is of the greatest importance, and where this had not been done, has proven the cause of much annoyance. Thus, to frame a hypothetical case: the Prince Imperial of France, son of Napoleon III and the Empress Eugenie, as is well known, met his death in South Africa at the hands of Zulus, during their war with England, and was found in the Veldt, pierced with seventeen assegai wounds. His body was embalmed, and brought back to England, where it now rests, perfectly well authenticated. Suppose, however, that by some chance his body had not been found, or, if found, had not been identified, or had perhaps been buried on the spot; what chances there would have been for adventurers of similar build and bodily appearance to have shown themselves in France before the sympathizers with the late dynasty, and claim that they were the lost heir, long the victim of a mistake, or of intentional fraud!

In fact, *claimants* of various sorts, ranging all the way from those who pretend to be heirs to modest estates to those who attempt to establish their right to thrones, form a class of most troublesome cases which often, after a lapse of centuries, continue to cause speculation. Plainly,

then, there is the greatest need of establishing the absolute identity of all such by means finally convincing and offering no room for doubt, if such means are ever possible.

Of the claimants to estates the famous "Tichborne Claimant" is one of the best known, as the case was continued in the courts of Chancery for some eight years (1866-1874), costing large sums of money. Roger Tichborne, the heir to a large estate in England, was born in Paris in 1829 and lived there until he was sixteen years old. He was then taken to England, where he was at school until 1849, when he entered the Dragoon Guards. In 1853 he went to South America, keeping up a continuous correspondence with his mother, but was lost at sea, somewhere between Rio and Kingston, Jamaica, in 1854. His ship, the *Bella*, was never heard from, and no survivors were ever known to have appeared. Everyone but his mother believed him lost, but she, after her husband's death, began advertising for him. On October 9, 1865, a man was found in Wagga Wagga, Australia, who confessed to being the missing heir. He came to England, and although he did not in any way correspond to the missing man, the mother believed that he was the lost son. Among the facts brought out were that he knew no French (!), remembered nothing of his school or of the studies there acquired, pronounced the Æneid of Virgil to be Greek, and declared that Cæsar was a Greek poet. More pertinent in our present line of investigation, he had no tattoo, whereas Roger had a tattoo in two places, but showed a brown birthmark on his side as a "proof" that he was the missing Roger. He tried on the Dragoon's helmet that Roger used to wear, but, even after removing the paper that was wrapped around the inside, found it altogether too small. He was finally identified by the Court of Chancery as one Arthur Orton, a butcher from the east end of London, and sentenced on February 28, 1874, to imprisonment for fourteen years. On his release, which took place in 1884, because of good conduct, he persisted in his claim, and went about in concert halls and dime museums doing a ten-minute "turn," in which he asserted his identity as Sir Roger Tichborne. About 1895 he published a "confession" in the columns of the *People*, a popular magazine, but later on recanted again, and denied the authenticity of this confession, which he charged to journalistic enterprise. He died in April, 1898, and on his coffin was inscribed "Sir Roger Charles Doughty Tichborne."

Still more remarkable, because more was at stake, have been the numerous claimants to thrones in every country of Europe, some of them long supported by a large party of adherents, or leaving a permanent doubt among historians.

Thus Frederick the Second, Emperor of Germany, and of the Holy Roman Empire, died at Ferentino, Italy, aged 55, in the year 1250. His unexpected taking off threw the empire into great confusion, and civil

wars raged for many years, tranquillity being restored with the election of Rudolf of Hapsburg as his successor in 1273. In the eleventh year of the reign of Rudolf, in 1284, there appeared an aged man, bearing a general resemblance to the late emperor, and asserted that he was Frederick. Tired of the world and of ruling, he said, he had not really died at Ferentino, but had retired to a monastery, first having arranged to have a body substituted for himself, and buried with due pomp. Naturally there were very few of his most trusted friends in the secret, and they had died in the meantime, leaving no witnesses of the transaction. Whether the old man's claims were true or not could never be decided, and the luckless claimant was burned at the stake.

At a later date the summary and unknown means taken by the wicked Richard III of England to rid himself of his two small nephews developed in later years a long series of pretenders, the majority of whom may be dismissed without more ado. The elder of the two would have been King Edward the Fifth, and according to general report was actually crowned in secret; the other, as the next heir, was another Richard, and King of England in the event of his older brother's death. As is well known, they disappeared during a night spent in the Tower, and there is a popular tradition, although not substantiated, that they were smothered in their beds by hired assassins. Their bodies were never found.

In 1491, some seven years after this occurrence, and during the reign of Henry VII, there appeared in Portugal a young, fair-haired Englishman who claimed to be the younger of the two princes, Richard, Duke of York. Taken up by the York party, hostile to the reigning House of Lancaster, the young man was brought first to Ireland, and then to France, his presence exciting hope and a spirit naturally rebellious to the King. He finally fell into the hands of his enemies, the Lancastrians, who, in 1499, compelled him to read from a public scaffold his "confession," stating that he was simply a fraudulent pretender, and that he was in reality one Perkin Warbeck, son of John Warbeck, and a Welshman by birth. The confession was, however, forced under threat of torture, and had no legal value. After this, however, he never regained his liberty, but after a long imprisonment was executed at Tyburn November 23, 1519. This case was always a mysterious one, and was never satisfactorily settled. Many have believed that he was really the claimant he asserted himself to be.

Probably no historic mystery ever raised so large a crop of pretenders as the case of the luckless son of Louis XVI of France, upon whom broke the full fury of the French Revolution. He was born at Versailles March 27, 1785, amid regal splendor, and christened Louis Charles. By the death of his older brother in 1789 he became the heir to the throne of France, the "Dauphin." After many sad adventures, including an un-

successful attempt to escape from the populace, he was torn from his parents, placed under the care of a degenerate beast of a jailor, "Black Simon," and finally is reported to have died in his prison June 8, 1795, at the age of ten years and two months. The emaciated body, scarred by ill-usage, and covered with the ravages of scrofula, was buried in an unknown spot, and never found.

As was to be expected in a case that offered so much inducement, and which was fraught with so much mystery, backed also by powerful political and religious parties, there developed from time to time no less than thirty claimants to the position of Dauphin of France.

Thus, among others, there was Hervagault, the putative son of a poor Norman tailor; Mathurin Bruneau, who, although a vulgar peasant, and the son of a maker of wooden shoes, became for a time a real menace to the government; Hébert, who came with an impossible tale of having escaped from his jailor enclosed within the body of a wooden rocking-horse; Naundorff, a Polish Jew, whose two children continued the claims after their father's death; and Augustus Méves, self-styled "Auguste de Bourbon." For Americans, however, there is always a peculiar charm in the story of Eleazar Williams, a boy of the same age as the lost Dauphin, who, when first known, was living among the "French" or "Christianized" Mohawks of Caughnawaga, above Montreal, as the foster (?) son of John Williams, a Mohawk with some English blood, derived from a captive from Deerfield, Massachusetts. Williams was very unlike his brothers and sisters, and, although the birth of each of these was recorded in the local parish register, that of Eleazar, or "Lazar," was not to be found. He had been considered by his associates to be almost a half-witted boy, but, receiving a violent blow on the head at the age of fourteen, the result of a fall, he regained glimpses of an earlier life, in which figured at first a beautiful lady (Marie Antoinette?) and much joy, and later intense suffering, mixed with suggestions of a hideous face! Somewhat later he and his foster-brother John were brought down to Longmeadow, Massachusetts, to be educated. Lazar responded with ease to the civilized surroundings, and learned with great rapidity; John was dull and uninterested in his studies, and after a brief stay returned to his Indian life. In Northampton Eleazar was thrown into a panic on being shown a likeness of Black Simon, the jailor. His body, also, showed the scars both of scrofula and of past ill-treatment. There are also stories of titled Frenchmen who made the pilgrimage to Caughnawaga and burst into tears at the sight of Eleazar, or who met Mr. Williams in later years, and affirmed the story of his birth; there is told, too, the tale of a French couple, accompanied by a young boy, who appeared at Albany in 1795, and who journeyed to the northward (Caughnawaga?); also that the lady had been maid-of-honor to the late Queen of France, Marie Antoinette,

mother of the Dauphin, and that both of them treated the boy with great respect and addressed him as "Monsieur Louis."

But this story, like so many others of like nature, must remain a mystery, although it is now rather generally discredited.

It is because of such intricate problems of individual identity, which are constantly met with in the courts, in both criminal and civil cases,

FIGURE 1. Man and woman of the Haida tribe, British Columbia, tattooed with heraldic emblems, signifying their totem, or family. The man belongs to the *Wolf* gens, and has the design of the supernatural wolf, the "Waska," split in halves, upon his back. The woman is a member of the *Bear* gens, and has the head of that animal upon her breast; also entire bodies of the same upon both forearms and upon both legs. Just below her shoulders, upon the upper arms, are eagles' heads, probably for pure ornamentation, but perhaps designed to mark the individual. (After Mallory and Swan.)

that the French writer of detective stories, Emile Gaboriau, wrote many years ago: "These difficult and delicate questions of personal identity are the bane of magistrates. Railroads, photography, and telegraphic communication have multiplied the means of investigation in vain. Every day it happens that malefactors succeed in deceiving the judge in regard to their true personality, and thus escape the consequences of their former

crime. This is so frequently the case that a witty attorney-general once laughingly remarked – and perhaps he was only half in jest – 'This uncertainty in regard to identity will cease only on the day when the law prescribes that a number shall be branded upon the shoulder of every child whose birth is reported to the Mayor'."* Whimsical though this proposal is, it is literally carried out among many primitive peoples, and the absolute identity of individual bodies is rendered practically certain by the use of various artificial marks, such as tattooing, scarification and the like.

In such cases, where the members of even neighboring villages are held in much suspicion, the first effort is to mark all the members of a

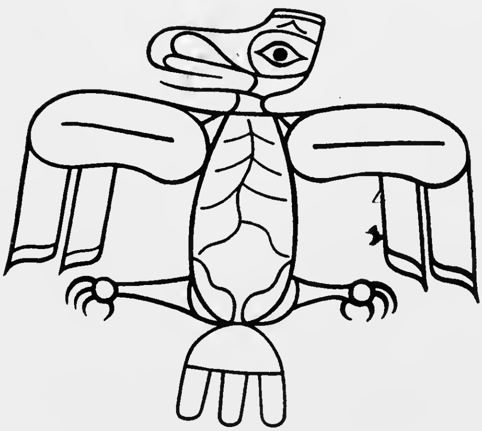


FIGURE 2. A Haida heraldic emblem, one-half natural size. This was taken directly from the back of a native of the *Thunder-bird* gens, and represents this creature, a popular character in their mythology. (After Swan.)

given community to insure them against being killed at sight by their countrymen, who might not know them personally and might mistake them for members of some other tribe. Thus, the first and most important mark is that of the village or gens to which the individual belongs, after which more detailed information may be conveyed in the same way.

Thus, in the two Haida Indians from British Columbia shown here (Figure 1), the tattooed patterns are heraldic emblems signifying their totem, or family. The man is of the Wolf gens, and has the design of the supernatural wolf, the "waska," split in halves, upon his back. The woman belongs to the gens of the Bear, and has the head of that animal upon her breast; also entire bodies of the same upon both forearms and upon both legs. The eagles' heads upon her upper arms are personal

*In "Monsieur LeCoq," Book I, Chapter XXI.

adornments, without special significance, but would serve to identify her to her friends and acquaintances, even though the body was found in a mutilated state. The second figure (Figure 2) represents a third emblem,

FIGURE 3. Woman from the Middle Congo region (Ileku, Coquilhatville), adorned with identification scars. These show her tribe, her village, and possibly her individual identity. Notice the raised crest up and down her forehead, the marks on her left shoulder, the three vertical rows of short scars on the chest, and the entire field of these covering her abdomen. A large crest of complex pattern, here scarcely visible, lies on the temporal region on both sides of the head, from eye to ear. (After F. Starr.)

that of the "Thunder-bird," used to mark the members of the family of that name. This was copied directly from the back of a native, and is given here at half the natural size.

Among the inhabitants of the Congo there frequently occurs an elaborate form of bodily decoration, consisting of raised scars, and other skin deformations, which mark most effectively the members of each village and declare their pedigree. The photograph shown here (Figure 3), taken by Prof. Frederick Starr of the University of Chicago, shows a comb or crest up and down the middle of the forehead, a long ridge on the left shoulder, three vertical rows of short scars on the chest, and the beginning of a series that cover the abdomen. On the profile of this same woman there is shown an elaborate mark placed horizontally across the temple, from eye to ear. Unfortunately we have not the key to this elaborate method of labeling, but like the Breton caps or other form of European costuming, there is indicated the village where the person lives and perhaps also details of rank and family. Such tribal marks are of the utmost importance among a primitive people, since in general all idea of ethics beyond the boundaries of the tribe are unknown, and a foreigner has no rights of property or of life, and may be killed at sight. This was the meaning of the "mark of Cain" in the old story in Genesis; the mark was no sign of disgrace, not the brand of a murderer, but the mark of the tribe to which he was banished, and granted in clemency as a direct response to Cain's fears, that he might be received as a member, and not slain at sight. It was the first recorded instance of a forged passport!

Clearly, then, the savages, with their plainly, although often hideously, marked bodies, have solved the problem of bodily identification with which we are vainly wrestling; the marks are given in youth, and can neither be eradicated without showing the signs of the attempt, nor can they be added in later life and look the same. Dead or alive, they can recognize their individuals without possibility of mistake; no old man can for a moment claim to be their lost chief; no stranger from elsewhere can claim to be a son of the tribe. A dead body, even badly mutilated, can be instantly and definitely identified, and no criminal can take shelter under an assumed name.

But by this time the reader may be asking, do we propose to go back to the savages and actually mark, tattoo, or otherwise disfigure the bodies of our citizens to insure an absolute identification? Are we taking seriously the fanciful suggestion of Gaboriau, whimsically introduced in the pages of a novel? With our wonderful modern surgery this could be done painlessly and safely; with our wearing of clothes the marks of identification could be readily concealed; and certainly, if we had no other way, the thing might be actually considered.

It happens, however, that no such artificial markings are necessary, for *every human being is marked by Nature, some months before birth, with a highly complex design, or system of designs, unchanged throughout life, absolutely individual and impossible to duplicate, and for a number of reasons, remarkably resistent to decay. These markings are, besides, easy to record, and quite possible to formulate and classify, making it a simple matter to find a given record out of a set of many thousands within a few minutes.*

We refer to the system of epidermic *ridges* (not the wrinkles) that cover the entire palmar surface of the hand, and the sole of the foot, every portion of which is so individual, if we take into consideration the microscopic details, *that by a comparison of a small area of this skin with a previously taken print of the same, an absolutely positive identification can be made.*

This system of identification by the *friction ridges*, as they are known to scientists, receives a full treatment in Part II of this work, where a special emphasis is put upon that portion of the subject already well known under the name of the "Finger-Print System," enabling it to be used as a practical manual for this work. Part I is devoted to other methods of identification, some of which are more obvious but less certain than that based upon the friction ridges; these methods are studied critically, and their deficiencies as well as their advantages are considered at some length. The work is thus made as complete as possible, since every known method by which an individual identification is possible receives at least some mention, while the more scientific and accurate ones are treated in detail.

CHAPTER II

SIGHT RECOGNITION AND ITS UNCERTAINTIES

"On sait en effet que tout animal diffère par certains points des animaux qui lui sont le plus semblables; et ces différences légères, que l'on rencontre communément chez les sujets du même espece, ont été désignées sous le nom de caractères individuels." — L. Blanc; Les Anomalies, etc., Paris, 1893.*

SIGHT recognition, the ability to recognize our friends and acquaintances by simply looking at them, depends upon two things: the extraordinary amount of variability of all parts of the human body, especially the face, and the relative permanence through life of the individual characters. We first learn the features of a new face; we gain the ability to recall it, with greater or less vividness, in the absence of its possessor; and, when this degree of knowledge is reached, we find it easy to recognize the same face, or even a photograph of it, when it is actually presented before our eyes.

If, now, we analyze further the appearance presented by an individual face, the things about it which we remember, and upon which we base our recognition, we find that a face consists of two things, the *features*, and the *expression*, the one more or less rigid and immovable, the other constantly changing under the influence of the mental moods of the owner.

The shape of the *features* is the direct result of that of the underlying bones, and as these vary individually in their curves, surfaces, and proportions, so the flesh which covers them exhibits as great a degree of variability. Individual skulls, as seen in an anthropological collection, vary as greatly as would the same number of living faces, and since the fleshy parts of a face show at any given point about the same actual thickness in all individuals, it is evident that the variation in the external features is mainly due to differences in the skulls. (See Chapter VII, below.)

The *expression*, on the other hand, which is largely occasioned by slight motions of the soft parts, is due mainly to the action of a thin layer of muscle, spread over the face like a mask interposed between the bone and the external skin, to both of which its fibers are attached in certain places. The action of the numerous semi-independent slips, the fibers of which run in different directions, causes the overlying skin to throw it-

*We know in fact that every animal differs in certain points from the animals that most closely resemble it; and these slight differences, which we commonly find among the subjects of the same species, are designated by the name of *individual character*.

self into furrows and wrinkles, dimples and ridges, under the influence of varying mental states, or as an unconscious aid to speech. As these changes are particularly individual and striking, and as they form a definite reflex of the very character, it is these, rather than the more rigid features, that one comes especially to recognize, so that a caricaturist may distort the proportions of a face as much as he likes, and yet produce a likeness easily recognized by simply preserving some of the most usual and characteristic lines produced by the facial muscles.

But, wholly apart from the face, every other portion of the body is equally individual. Although ordinarily covered by the clothing, the peculiarly individual proportions of muscle and bone, as they occur in arm or chest, hip or leg, make themselves almost as clearly manifest in the gait and habitual gestures, as though the subject stood unclothed before the observer. The voice also, one of the most distinctly individual of human traits, is modified not alone by the qualities of the vocal organs themselves, but equally by the configuration of such adjacent parts as the walls of the chest, the bones of the face, and the configuration of the nose. It was once the experience of one of the authors to recognize a man sitting in the reading-room of a public library, entirely concealed by an open newspaper, through the slight noise the man made in clearing his throat. As with the individuality in the tones of a given violin, due to the exact form, proportions and materials of which the box is made, so this man, and this man alone in all our acquaintance, was built in the precise way to render possible the exact quality of tone shown in his every vocal utterance.

It would seem, then, with the well-nigh endless possibilities of variation in every way, that sight recognition of a man once known would be in all cases absolutely reliable, and that a mistake in identity, when a full opportunity for examination is given, could never occur. Yet in actual experience one is frequently seeing people whom he thinks he recognizes only to find that he has accosted an entire stranger, and a few experiences of this kind make him more charitable to the unknown man who takes him for an old acquaintance. Every president or other figure of national importance has at least one "double" whom the newspapers are fond of exploiting, and the close resemblance between King George V of England and the ex-Czar of Russia, Nicholas Romanoff, is surprising, even taking the close relationship into consideration.

To this close resemblance of certain individuals, a repetition of types, as it were, are due the frequent awkward mistakes, which are within every man's experience, and which cause much annoyance. Typical of these is the following instance, extracted from a letter. "When Dr. R—— was married, a friend named T—— 'stood up' with him, and the intimacy continues to this day. Some few years ago Dr. R—— was in the smoking

car of a train, returning from a football game. Facing him, on the other side of the car, and about ten feet away, was T——, and Dr. R—— smiled, nodded, and waved his hand at him. As the latter made no sign of recognition Dr. R—— thought he was irritated at something, and went over to him, took hold of his arm, and shook him familiarly, saying at the same time, 'What is the matter with you? Why don't you speak?' The man replied, 'What is the matter with *you*?' and then Dr. R—— saw that the man was a stranger, yet had spoken to him and even shaken him before he found it out."

In much the same way one of the authors saw what he thought to be his college roommate, sitting obliquely across the aisle from him in a train, but, as he had no reason for expecting to see him within a thousand miles of the spot, he waited for some time before speaking, meanwhile studying him critically. And in every detail he stood the test. The profile, the half side face, with prominent and characteristic cheek bones, were exact in every particular, although the friend was of rather unusual appearance, and could not be easily duplicated. Like the roommate, this man wore gold-bowed glasses, the bows cutting into the flesh of the temples in the familiar way; and the gestures and the posture, too, as he talked with two ladies, were also perfectly natural.

In spite of all these coincidences, however, natural and artificial as well, the man proved to be an entire stranger, as was later established beyond all doubt, yet even after engaging the stranger in conversation, much of the deception still remained.

To the other author a similar experience came in much the same way. In the autumn of 1908 he was on the train coming from Portland, Maine, to Dover, New Hampshire, and in a seat about fifteen feet in front of him sat a lady from the latter place, known to him from her childhood. She was in company with a gentleman and a little boy. This lady, who was remarkably handsome, and of a type rather unusual, had her hair done up in the way she was accustomed to wear it ordinarily, and was wearing a wide black hat. The car was well lighted, and as the author knew that the individual in question had a husband and little boy, it never occurred to him to doubt the identification. The technical conditions for a complete identification were perfect, as recognized by the courts; i. e., the witness was (1) sober, (2) not under any excitement, and (3) not in fear. Yet when he passed out of the car at Dover, and went by the person, she proved to be an utter stranger, and on seeing her full in the face, almost all resemblance even was lost. Here the recognition was plainly based upon certain proportions and other characters as they appeared from a single point of view, strengthened perhaps by the probability involved, *yet many a time in the court a similar faulty recognition passes for evidence*, and that, too, of a kind to be taken by the average juryman as absolute proof.

Even among the restricted circles of those coming within the jurisdiction of police bureaus there are occasionally cases of close similarity. The three photographs shown here (Figure 4) are those of three separate men who have come under the surveillance of Scotland Yard, and are extremely difficult to tell apart. That this close similarity does not extend to the finger prints is seen by comparing the prints of the three right

FIG. 4. Photographs of three men who closely resemble one another. The patterns of the right thumbs, shown below the respective portraits, are distinctly different, although the two on the right belong to the same class of patterns. These photographs have been extensively quoted, but came originally from Scotland Yard, London.

thumbs, attached to the corresponding photographs. These, although in two cases somewhat similar, cause no difficulty in distinguishing them.

The second case, in many ways the most remarkable on record of the physical duplication of two unrelated individuals, and rendered still more incredible by the coincidence of the name, is yet established beyond all possible doubt, and the photographs and other data here presented came from the United States Penitentiary at Leavenworth, Kansas, where they were originally collected.

It appears that, in the year 1903, one Will West, a new prisoner, was

committed to this institution. (Figure 5.) A few days after his committal he was brought into the office of the record clerk to be measured and photographed. The clerk thought that he remembered the prisoner, and said, "You have been here before." "No, sir," answered West; but, as the

Fig. 5. The Bertillon photograph of Will West, No. 3426 of the United States Penitentiary at Leavenworth, Kans.

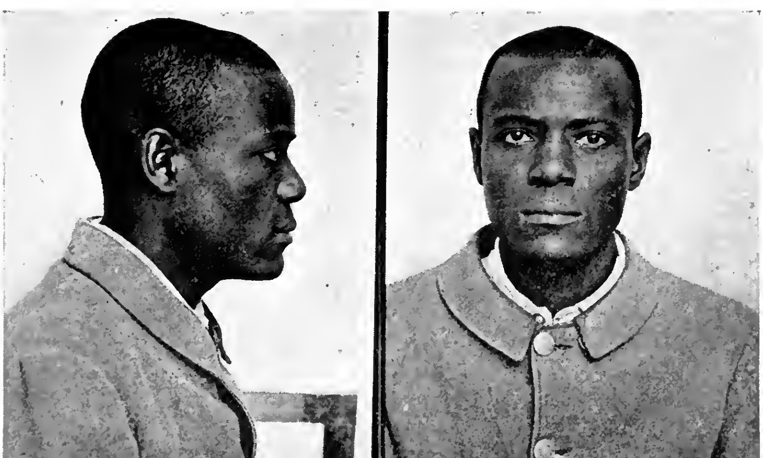


Figure 6. The Bertillon photograph of William West, No. 2626 of the United States Penitentiary at Leavenworth, Kans. This is a different man from the foregoing (Figure 5), but has practically the same Bertillon measurements, and almost the same name. Both were at Leavenworth at the same time.

clerk was positive, he ran his measuring instruments over him, and, from the Bertillon measurements thus obtained, went to the file, and returned with the card the measurements called for, properly filled out, accompanied with the photograph and bearing the name "William West" (Figure 6). This card was shown to the prisoner, who grinned in amazement, and said, "That's my picture, but I don't know where you got it, for I know I have never been here before." The record clerk turned the card over, and read the particulars there given, including the statements that this man was

FIGURE 7. The two left index patterns of the two West negroes of Figures 5 and 6. That of Will West (a) (3426) is an Inside Whorl by 11 ridges; that of William West (b) (2626) an Invaded Loop, with a count of 18 ridges. Thus while the faces and figures are sufficiently similar to cause confusion, there is absolutely no similarity in the finger prints.

already a prisoner in the same institution, having been committed to a life sentence on September 9, 1901, for the crime of murder. That is, the card found was that of a different man, still within the walls of that very prison, yet of the same name, the same facial expression, and *practically the same Bertillon measurements* as the newcomer! It then dawned on all present that there were two Will Wests, and that here was a case of the most re-remarkable resemblance of two unrelated persons on record; since neither photographs nor the Bertillon measurements were of any avail in estab-

lishing the identity of these two men. The clerk writes that, with their hats on, it is almost impossible to tell these men apart.*

This case, where so close a resemblance exists between two individuals not related, is, of course, unique, but an occasional close similarity between twins, even to the point of frequent confusion of the two, is known to everybody.

In the opinion of biologists, and resting upon direct observation, as well as experiments upon lower animals, there are two distinct classes of human twins, *fraternal* and *duplicate*, the distinction between which, outwardly manifested by the degree of resemblance, rests upon a fundamental difference in their origin. Normally every individual animal, man included, arises from a single microscopic cell (the "egg," or *ovum*), developed in the ovary of the female (mother), and fertilized by a single sperm cell secreted by the male (father). It is also probable, although actual material proof is wanting, that the fertilized egg contains potentially all of the inherited qualities that come out in the adult, and thus that a given combination of egg and sperm can produce one sort, and only one sort, of an individual. Many mammals develop normally at one time a number of different ova, but, as these are fertilized each with a separate sperm, and as no two eggs and no two sperms contain exactly the same inheritable qualities, every fertilized egg differs from the rest, and results in a special individual, unlike all his brothers and sisters. Some other mammals, principally the larger ones, like the mare, the cow, and the elephant, usually ripen a single egg at a time, and thus produce a single offspring at each birth, more or less unlike the rest of the family. Occasionally, however, two, or even more separate ova, will ripen simultaneously, as is the rule among smaller mammals, and these, fertilized by separate sperm cells, are just as unlike as though they had been born at different times. These are twins, because born at the same time, but they are of the *fraternal* (or brother and sister) type, and no nearer related than are brothers and sisters of different births, and with the same two parents. They may be of the same, or of opposite, sex, with 50 per cent chance either way; they may resemble each other, just as two single children of the same family may also; and again they are just as likely to be very unlike in every way. On

*While the apparent identity of these two men may be seen from the two photographs here reproduced, the finger prints are as distinct as in any two chance individuals. This is seen from the prints of the two left index fingers, shown in Figure 7. The Bertillon measurements, stated in the text to be practically identical, are the following, taken from the identification cards of the United States Penitentiary at Leavenworth, Kansas.

Will West	19.7,	15.8,	12.3,	28.2,	50.2,	1.78.5,	9.7,	91.3,	1.87.0,	6.6,	14.8
William West	19.8,	15.9,	12.2,	27.5,	50.3,	1.77.5,	9.6,	91.3,	1.88.0,	6,6,	14.8

These might easily have been taken from the same man at two different times, or by two different operators.

the other hand, it is also possible, although the causes and details of the process are not fully known, that a single fertilized egg, containing the hereditary material sufficient to determine the traits of a single individual, may separate into two distinct and separate embryos, each of which develops from that point on, as if it were a normal one, and the result is *two separate individuals made out of the same hereditary material, and naturally duplicates.* These twins are of the type known as *identical or duplicate*, and are biologically more nearly and intimately related than any other individuals can be. They are always of the same sex; both boys or both girls, and during their intra-uterine development they are

FIGURE 8. Twin daughters of Mrs. B. Hill of Southsea, England; called the "Virol Twins," as the photographs of these little girls were extensively used in advertising an English infant food of that name. This picture, in advertisement form, was first sent the authors several years ago by Prof. John Beard of the University of Edinburgh, but more recently original photographs were sent them directly from the Virol Co., Ltd., with full permission to reproduce here. Their courtesy is hereby acknowledged.

more intimately associated than are twins of the other type, being wrapped within the same fetal covering, the chorion. This fact has given them still another name, that of *monochorial* twins, which emphasizes the fact of their being included within a single chorion.

Twins of this type have been experimentally produced in quantity from single eggs in certain of the lower marine creatures, such as sea-urchins, and star-fish, whose eggs, floating free in the water, are especially

favorable to experiment with, but with such animals as the mammals, where the early stages of the development take place within the body of the parent, such direct experimentation is thus far impossible; yet, as we are dealing with principles that in other respects have been shown to be of universal application, it is certainly not too much to claim that, where we find in nature results in every respect similar to what we may produce experimentally, the conditions and causes must be similar also.

We have then, presumably, in a pair of duplicate human twins, two in-

FIGURE 9. A set of triplets born in Athol, Mass., in the '40's of the last century. This photograph was taken in the early '60's. These girls were named in order, from left to right, Mary, Maria, and Mahala. All three married and bore children. Two of them died of cancer.

dividuals made of the same hereditary material, minute particles of the germ cells which, under usual conditions, would have handed on to a single individual a certain combination of the qualities possessed by the two parents. By a complete separation of this material at almost the beginning of development two embryos are formed instead of one, and the two necessarily develop in exactly the same way, in exact parallel course, thus eventually producing two identical individuals capable of causing much confusion, at first in the nursery, where they are sometimes hopelessly mixed up, and later in active life. (Figure 8.)

In rare instances, too, there are born, not merely two duplicates, but three that are identical, although in most cases of triplets there is a single pair of duplicates and a fraternal member, which may be of the same sex as the two others or not. It is also possible to have a set of triplets, all fraternal and distinct in appearance, which forms a case parallel to the usual condition among dogs and cats, with several individuals in a litter.

A good case of "identical" triplets, who lived in western Massachusetts during the nineteenth century, is here presented as photographed in the '60's. (Figure 9.) The severity of the fashions of the day concealed much of the youthful and spontaneous, yet those who remember these three young ladies, in order, Mary, Maria, and Mahala, describe them as most attractive, piquant and lively, and as taking a mischievous pleasure in deceiving their associates as to their identity.

It was related of them while still in the nursery that one of them was found complaining that she had been given three baths that morning, while the other two were in high spirits at their unexpected exemption; a story which strongly emphasizes the bodily similarity of the three children. At first glance the one on the observer's right, Mahala, looks a bit unlike the two others, but it will be seen on closer inspection that she has neglected to put in her earrings. The neckwear differs also a little, probably intentionally, to aid their friends in distinguishing them.

If, now, having considered the problem of different individuals who look alike, we turn to the well-known phenomenon of the same man's capacity for looking different at different times, we find another element of difficulty in the problem of really identifying a man at sight. We are all familiar with the profound changes that take place in boys and girls during adolescence, especially between the ages of twelve and eighteen; it is also true to a lesser extent that people change during middle life, although the changes are here slow and less marked. The advent of old age again produces changes, sometimes very striking. Again, the influence of external circumstances, such as, on the one hand, a hard life, a bitter experience, or a series of misfortunes, and, on the other, continued prosperity, a tranquil life, free from excitement and without care, produce profound modifications of the external appearance within a few years, so that after an interval intimate associates may become mutually unrecognizable. With men, a change in wearing the beard, a change that may be effected by a razor in a few minutes, may produce a startling alteration in the appearance; and in women almost as marked a modification may be effected by the coiffure or the style of dress. Thus a photograph of a person taken ten years ago sometimes is of little value in recognition, and when a person attempts voluntarily to modify his appearance in order to escape recognition he can add greatly to a problem by no means an easy one at best. The profound difference that may exist in two photographs of the same in-

dividual, although with a short interval between them, is shown in Figure 10, where probably there was conscious effort employed to emphasize the difference. As in Figure 4, a single finger print is shown with each photograph, the pattern of the left middle finger. The photograph and print on the left were taken in Toronto, in November, 1908; those upon the right in Old Town, Maine, in December, 1909.

In spite of the almost insurmountable difficulties in the way, however, sight recognition is frequently the only means available for the indenti-

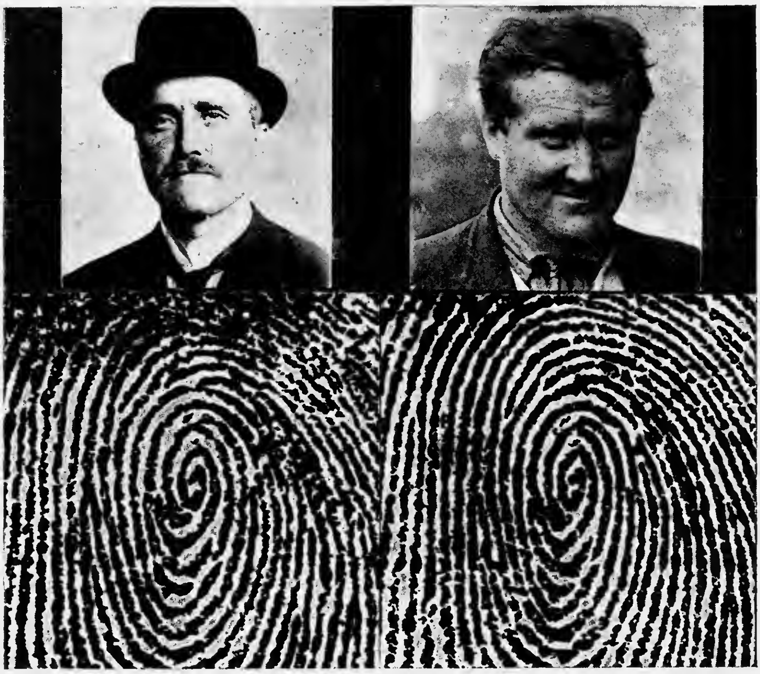


FIGURE 10. Two photographs of Frank Murray, the one on the left, taken in Toronto, Can., in November, 1908; the other in Old Town, Me., in December, 1909, a year apart. The two would hardly be taken for the same man, but the prints of the left middle finger, taken at the same two times as the photographs, show the complete identity.

fication of a criminal, although seen but imperfectly, and then under the influence of great mental excitement. Is it strange, then, that cases of mistaken identity are alarmingly frequent, and that criminal history is full of cases in which, by relying upon such uncertain testimony, perfectly innocent men have been compelled to serve long terms of imprisonment, or to submit even to the extreme penalty of the law. There is too much ground for fear that many mistakes have occurred in the lynching of

negroes, where the excitement of the occasion, the blind rage developed by the circumstances of a revolting crime, the haste and evasion required in order to consummate the execution, and, not the least, the fatal resemblance which negroes often have to one another in the eyes of white men, all have conspired to foster mistakes and to condemn innocent and well-intentioned men to an excruciating and ignominious death.

The following instances, taken from the notebook of one of the authors, will be found suggestive in the matter of the reliability of the average witness in matters of sight recognition:

Two young men were in the Dover Police Court for being disorderly on a train coming from Portsmouth to Dover about nine in the evening of the day before. Both were identified as the men in question by the conductor of the train and by Dr.———, a former Dover physician, and both witnesses had had eleven miles in a well-lighted train during which to fix the faces on their minds. The two were arrested upon the station platform at Dover, immediately after the arrival of the train. Yet upon examination the police found that one of the young men under arrest could prove a complete alibi. He had not been upon the train at all, but had gone to the railroad station in order to take the train for Lawrence, Massachusetts. Both witnesses were thus absolutely mistaken in the identity of one of the culprits, even under the most favorable circumstances, so that the Associate Judge who presided at the trial said, "How is that for identification? Suppose a man's life depended upon it?"

The other case was that of a young man named P———, who went to the livery stable of John S———, in Rochester, New Hampshire, and hired a horse and carriage, which he never returned. A very poor picture of P——— was obtained, and handbills were printed and sent broadcast. Among other descriptive remarks it was stated that P——— was possessed of considerable musical ability, and had been employed as piano player in a roadhouse out in the country. A few days after this the author, who had charge of the case, was called to Portsmouth, New Hampshire, and was told by the City Marshal that there was someone in a certain cell that he (Wentworth) wanted to see. The prisoner answered the description of P——— exactly, except in the eye color, which was brown instead of blue, the color given by the livery stable keeper. When arrested this man was playing a piano in a disreputable resort; he had considerable musical ability, combed his hair in the way described, and so on. Mr. S———, the liveryman, came on from Rochester, and positively identified the prisoner as P———, at which the prisoner turned so white that it was feared he would faint. S——— kept repeating, "That's the fellow, that's the fellow; you have got the right one." In spite of all this the friends of the real P——— said that the prisoner was surely not he, and they were right, for P——— was found later in New York State, and the horse was recovered

by the aid of a sister of P——. Here the circumstances were ideal for a true identification. S—— had the chance of looking at P——, during the ten minutes or more necessary to get the carriage ready; he was wholly sober during that time; it was in broad daylight, and there was no state of excitement or fear.

As further illustrations of the danger of relying upon sight recognition and the unreliability of even the best of witnesses under ideal conditions, we may cite a number of recent cases, in which sight recognition alone would have resulted in the punishment of innocent victims.

On February 3, 1908, the postoffice safe at Salisbury, Massachusetts, was robbed. January 10, 1910, a man named M—— was put on trial for the crime, and positively identified by witnesses. At the trial Lieut. O. P. Perrill of the receiving ship *Wabash* testified that M—— was a prisoner on board his ship from January 24 to February 18, 1908, and could not possibly have been at Salisbury the night of the robbery.

On November 6, 1909, a safe belonging to Schuyler Rayner, of Florence, New Jersey, was robbed by a masked man, who nailed the aged housekeeper into a room and escaped. One H—— was identified by the housekeeper as the robber; a clergyman also testified that he had seen said H—— about the premises. Upon this testimony H—— was arrested, but released from jail under heavy bail. A short time later one Joseph E——, arrested in Chicago, confessed to the Florence robbery, and restored the money taken.

On May 4, 1908, Nelson F. R—— was tried in the United States and State Courts in Chicago for forgery and swindling. He was positively identified by thirty men, including a handwriting expert, and a patent attorney from Washington, who swore that on a certain day R—— had given him a forged check; yet, upon the day in question R—— was proven to have been in jail in Chicago.

In Canton, Ohio, one Maurice S——, who had already served six months in jail for robbing a cigar stand, was released upon the confession of a brother, who stated that it was himself, and not Maurice, who committed the robbery. In this case there was a strong resemblance between the two brothers, yet the identification of Maurice had been legally complete and positive, as declared by reputable witnesses, resting their claims upon sight recognition.

The cases thus far cited include only those in which an innocent man has been wrongly identified as the criminal, yet the opposite is also possible, the non-recognition of the criminal even by the victim. On the 13th of July, 1914, two little girls, E., aged 9, and F., aged 11, were assaulted by a man, dressed in a blue suit and cap, no vest, and a light shirt. The older girl escaped, but the younger was carried off, abused, and finally tied to a small hemlock tree, and left in the woods to die. She managed to free

herself, and wandered until she came to a house, from which a telephone call was sent, through which the criminal was caught. Within two and a half hours after the assault the man was brought before both little girls, and both said that he was *not* the man, although the fellow confessed 48 hours later. Meanwhile, when still at large the man had replaced his light shirt for a black one, and he also appeared to be that kind of a person whose hair is ordinarily straight, but crinkles into fine curls when moist from perspiration, and these differences were sufficient to cause both little girls to fail in their recognition of him.

Such cases might be indefinitely multiplied, each dealing with reliable witnesses, generally those who made their observations under favorable conditions, and resulting either in the punishment of the innocent, or the escape of the guilty. It must also be remembered that while these cases were selected because the truth eventually came out, there are countless others where it never does, and there are doubtless now behind the bars, deprived of their liberty and undergoing unmerited disgrace and punishment, many innocent men, convicted upon the uncertain testimony of sight recognition.

In view, then, of the facts presented in this chapter: first, the extraordinary resemblance possible between two individuals; second, the great amount of change in appearance of which a single individual is capable; third, the known unreliability of eyes, memory, and judgment under the influence of excitement, fear, or other mental emotion; and *fourth*, the numerous instances in which a sentence based upon sight recognition has proven erroneous and has worked the greatest injustice upon the innocent; is it not our duty to employ sight recognition as contributory evidence merely, and to seek for better and surer methods of effecting a true identification? The outcome of this inquiry is plainly and irrefutably this: *Sight Recognition is not Identification.*

CHAPTER III

IDENTIFICATION BY MOLES, BIRTHMARKS, SCARS, TATTOOING, AND OTHER MARKS UPON THE SURFACE OF THE BODY

"*Viola: My father had a mole upon his brow.*
Sebastian: And so had mine."— Twelfth Night, Act V; Scene 1.

ALL civilized literature, reaching back into a dim antiquity, and extending forward to the modern novel or light opera, is sprinkled here and there with instances where a positive identification is made by means of some individual peculiarity of the skin surface. The identity of Ulysses, the hero of the Homeric poem of the Odyssey, was disclosed to his old servant, Eumeces, when he returned to his home disguised as a beggar. While bathing the stranger's feet, according to the usages of hospitality at the time, Eumeces discovered the scar left by a boar's tusk in an early hunting adventure in which both had participated in their youth, and wept for joy at the disclosure of his master's identity. Identification by means of a mole and a "sign," the latter probably a birthmark, plays an important part in the Arabian Nights' tale of Hassan of Bassora and the king's daughter of the Jinn (807th night), where Hassan describes his lost wife to the old woman Shewahi, that she may find her; and in a tale of Boccaccio (2d day, 9th tale) Ambrosius, on a wager with Bernadô Lancellino, enters the chamber of the wife of the latter at night, and observes her as she lies asleep. The plot hinges upon the description of a mole upon her breast, as a proof of her infidelity. Precisely the same tale is told by Shakespeare in "Cymbeline," who puts this old tale in a new setting, and places the identification in Britain, instead of Italy. That Shakespeare was fond of the mole motive is shown by a second use of it in the quotation at the head of this chapter.

One more illustration from mediæval literature is interesting because of the minute details given. It is from the old Italian novelist of the sixteenth century, Matteo Bandello, and is found in his tale entitled "Ligurina, having been carried off at the sack of Genoa, is long after recognized by her kinsfolk and put in a nunnery" (Part II, 3d story, Paine's translation). The incident is as follows: "For all that she said there was none that knew her; but her mother, remembering her of a mole which Ligurina had near the navel, with seven or eight little hairs black as quenched coal, said, 'If this be our daughter I shall soon recognize her, for that she hath a token which cannot lie!' Then . . . she went up to Ligurina, with

eyes full of tears, and, unlacing her gown, to which she fully consented, saw the mole, as she had seen it a thousand times before, and viewing her more closely, knew her for certain to be that daughter whom she had lost at the sack of Genoa."

In police descriptions such bodily marks have always found a place, but here the untrained official meets with numerous difficulties. Without technical knowledge he finds himself under the necessity of distinguishing between the various sorts of skin blemishes; he needs also to describe, or to understand when described, definite locations upon the body, accurate within an inch or so. The proper terms for expressing location, known to physicians and anatomists all over the world, and employed by all civilized languages under slightly different forms, are naturally unknown to him, and he composes phrases as best he can, liable to be misunderstood by his colleagues and scientists alike. A good illustration of this is found in the frequent newspaper accounts of minor injuries, especially those involving the hand and fingers, and in which terms like "last joint," "third joint," "fourth finger" and the like constantly occur, yet without a clue as to which end of the finger the counting began, or whether the thumb was or was not included in the finger count. Even in a good average description, given out recently from a state penitentiary, we find the following, which may be very easily misunderstood:

"H shaped scar 1st ph, rear 3d left finger."

Here the "third finger" may be either *medius* or *annularis;* the "first phalanx" may be either *basal* or *terminal.* The term "rear," an untechnical expression, seldom used, is found, by referring to other reports from the same institution, to be used as opposed to "front," signifying respectively *dorsal* and *palmar* (*ventral*). An exact expression for this, understood equally well by the police of Germany, France, or Italy, and without the possibility of two interpretations, would be, with the order changed, so as to put the more comprehensive terms first:

H-shaped scar lft. med. bas. ph. dors.

Into this chaotic condition of things, where the police of all countries, ignoring the proper terms used the world over by physicians and scientists, used any phrases that occurred to them at the time, and where also different institutions developed each its own usages, came Alphonse Bertillon, who, educated as an anatomist and anthropologist, brought his scientific mind and training to bear upon the matter of accurate description of individual bodies. Aside from his method of bodily measurements, his most distinctive contribution, his work embraced many other descriptive methods, among them one for the detailed description of bodily marks.

To simplify the problem of location he first divided the entire body into six regions, to be referred to by numbers, as follows:

I. Left upper arm and forearm; the left hand.
II. Right upper arm and forearm; the right hand,
III. Face, and the front of the neck.
IV. Chest, front of shoulders, and the part of the stomach situated above the waistband of the trousers.
V. The back of the neck, and the back, to the same limit as given in IV.
VI. The other parts of the body, where there are anomalies to be noted.

Each of these parts is again divided into definite regions, designated by abbreviations. Thus, for Parts I and II, which are alike in their details, the subdivisions, with their abbreviations, are as follows:

Forearm (cubitus)	cb
Biceps (region of front of upper arm)	bcp
Wrist (poignet)	pg
Base of thumb	bsP
Pollex (thumb)	P
Index (forefinger)	I
Medius (middle finger)	M
Annularis (ring finger)	A
Minimus (little finger, Fr. *auriculaire*)	O
Palm	pm
Finger (digit, Fr. *doigt*)	dgt
Joint (articulation)	j
Phalanx (a joint in the other sense)	f
Space between thumb and index	P-I, etc.

The basal joint of a finger is numbered 1, the middle one 2, and the terminal, 3.

The following general terms are used, including those for relative location, and direction toward or from a definite spot:

Left (s. for Lat. *sinister*=left)	𝔰
Right (German D for Lat. *Dexter*=right)	𝔇
Anterior	α
Posterior	ρ
Above (superior to)	—⌒
Below (inferior to)	—⌣
Behind (Fr. *arrière*)	ari
Before (Fr. *avant*)	avt
Median line	md
Internal, inner (Greek letter, iota)	ι
External, outer (Greek letter, epsilon)	ε

Shapes, used especially for scars:

Straight, rectilinear	r
Curved	c
Oblique	b
Broken	br
Square (Fr. *quadrat*)	qr
Circular	circ
Horizontal	h
Curved, concavity above (superior)	
Curved, concavity below (inferior)	
Curved, concavity forward (anterior)	
Curved, concavity behind (posterior)	

For lengths and distances the metric system is used, and numbers always refer to centimeters (cm.). Millimeters are given after the decimal

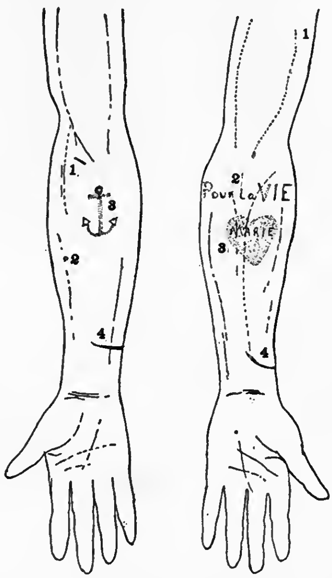


FIGURE 11. Diagrams of an arm with the usual types of surface markings, to illustrate the Bertillon method of description. Further explanation in the text. (After Bertillon.)

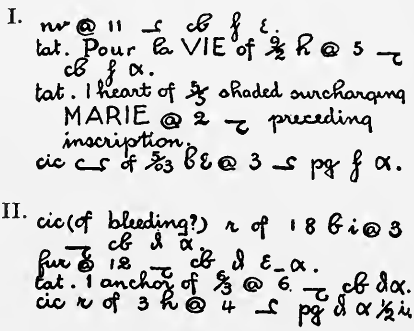
point; thus, "cic. r of 3.5" is read, "straight scar of 3 centimeters and 5 millimeters."

Other abbreviations refer to the sort of mark, whether scar, mole., etc. Thus:

Scar (Fr. *cicatrice*)	cic
Mole (Lat. *nævus*)	nv
Tattooing	tat

Boil (Lat. *furunculus* Fr. *furuncle*)	fur
Dimple (Fr. *fossette*)	fst
Smallpox (Lat. *variola*)	var
Scrofula	scrof

Bertillon, in his manual,* gives a number of illustrations of the use of this system, accompanied by the sketches he describes, and the reader is referred to this for details. Here it is sufficient to present one or two of these, to render the description more complete. Thus, in Figure 11 are given front views of a subject's two forearms, the details of which are thus expressed by the Bertillon system:



Described in full, the above would read as follows:

Left arm

1. Mole at 11 centimeters above point of left elbow, outer side.
2. Tattooing, "*Pour la vie,*" dimensions 9 x 2 centimeters, placed horizontally at 5 centimeters below elbow, on the front side.
3. Tattooing, a heart, dimensions 5 x 5 centimeters, shaded, surcharging the name "Marie" placed 2 centimeters beneath the preceding inscription (2).
4. Curved scar, with the concavity upward, 5 centimeters long and 0.3 centimeters broad, obliquely placed 3 centimeters above the outer side of the left wrist, on the front side.

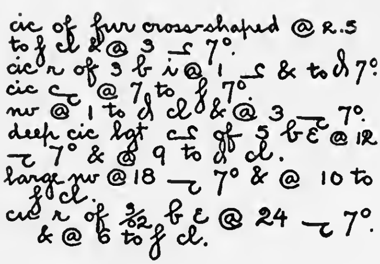
Right arm

1. Scar, perhaps from being bled, straight, 1.8 centimeters in length, placed obliquely on the inner side, 3 centimeters below the elbow, on the front aspect of the right arm.
2. Scar from a boil, 12 centimeters below right elbow, on the front, outer side.
3. Tattooing, an anchor, 6 x 3 centimeters in size, placed 6 centimeters below the right elbow, front side.
4. Straight scar, 3 centimeters long, placed horizontally, 4 centimeters above the right wrist, on the front, and partly on the inner, side.

*The Bertillon System of Identification (Engl. transl.), 1896, edited by Maj. R. W. McClaughry, late Gen. Supt. of Police, Chicago. The Werner Co., Chicago, Publishers.

In concluding this subject we present one further example, which we leave to the ingenuity of the reader. It describes the marks on a man's back, the part uncovered when he stands with shirt removed but with the trousers retained. It also is given in Bertillon, and figured in his Plate 76, which may easily be consulted to corroborate the reader's translation.

V.



In this *lgt* equals *slight; cl* equals vertebral *column;* and the oft recurring 7° signifies the point of the seventh cervical vertebra, or *vertebra prominens*, the conspicuous median point at the base of the neck, where the collar button sometimes chafes. It may be rendered more pronounced in a subject if he bend his head down.

Although the difficulties that appear at first glance soon disappear as one studies this shorthand system of description, it still shows plainly that it was primarily a personal method, such as one who has much note-taking to do naturally develops for himself, rather than a broad international system, of universal application. In the English edition of Bertillon the system has been improved for those of English speech by a proposed substitution of English abbreviations in cases where the French or Latin form was very unlike the word in our language. Thus, *right* and *left* in place of the characters standing for the initial letters of the Latin *dexter* and *sinister; sm* (*small*), instead of *p* (*petit*); *scar* instead of *cic* (*cicatrice*); *mole* instead of *nævus*, and so on. Yet there is still room for a complete new system, consisting of abbreviations easily understood internationally, and taking into consideration convenience, anatomical accuracy, and simplicity of application.

The present practice in the United States varies with the institution, but there are few that show no Bertillon influence in the descriptive phraseology. In some cases the Bertillon abbreviations, even those based on French or Latin words without English equivalents, are faithfully adhered to, although *nv* or *nævus*, has scarcely obtained a foothold. Inches, too, are often preferred to centimeters, and in some instances both exist in the same description. The words *front* and *rear*, used for the side presented, when the subject is standing before the examiner, are almost universal,

but are to be objected to as inapplicable, save in one position of the subject, and of no significance in describing a body. For these and all such terms there should ultimately be substituted terms applying to definite body regions, irrespective of position assumed. Thus, *palmar*, with reference to a hand, means the palm side, and can mean nothing else; *dorsal* means the back, or the side corresponding to the back; *ventral* means the stomach, or the stomach side of an arm or leg, and so on. Two very convenient terms referring to a position on a limb (arm, leg, finger) are *proximal* and *distal*, toward the body and toward the tip respectively, and it removes all ambiguity to call the three finger joints the *basal*, *middle*, and *end* (or terminal) instead of numbering them.

That our descriptive nomenclature needs a thorough revision, which will render possible the use of the same method everywhere, may be seen from the following examples, taken at random from various institutions, among them some of the largest and best equipped.

A. An institution that follows Bertillon in large part.

Case 1. I. Cic. of 1.3 @ 2nd. f index anterior and inner.
II. — — — —
III. Mole of 5 x 5 neck posterior @ 1 from median line.
Cic. of 5 x 7 @ left thigh front and inner.
Frontal and occipital baldness. Wears a wig.

Case 2. I. Cic curved concavity inferior of 4 @ 3rd. f middle finger front and inner.
II. — — — —
III. Cic recti of 3 oblique inner right brow inner.
Cic of burn left foot.
Mole round of 1 @ pt. of right shoulder.

B. An institution that simply abbreviates, not always using the same letters for the same word, and again writing out the word in full.

Case 1. I. Scr hori 2c below wrt frt.
II. Mole 7c abv wrt out.

Case 2. I. Scr vac 1½ x 1½ 8 abv elb out; tatt eagle and flag, 11 x 10 6 bel elbo frt;

II. Tatt woman, 13 x 5½ 4 belo elbo frt; scr irreg 4 x 4 abv elbo in; arm crooked at elbo.
III. Scr obl 1½c on R forehead 4c from M line 3c abv R eye; scr obl extending fro bridge of nose to in cor R eye; both eyes strabismus divergent.

C. This institution seems to use the Bertillon order in describing the parts of the body, i. e., first the left arm, then the right, then the face, and

so on, but does not indicate the classification, and sometimes confuses the regions. Only a few abbreviations are used.

> Case 1. Round sc of 1½ in [inches?] diam 3 above wrist, R f forearm rear; mole in right eye row; mole 3 to rear of right eye on temple; birthmark 3 long 3 wide on back of neck; mole on left 2 in front left tragus; diag sc on neck 2 below lobe left ear; mole on left cheek 7 in front of lobe left ear; blue mark 1 long 1 wide upper lip under left nostril.

Here probably the numbers mean centimeters, but the first, followed by the abbreviation "in," seems to signify inches. Sometimes, in descriptions from this same institution, the word "inch" appears written in full; also the numbers used without designation would sometimes be too long for the place in which they are located unless they were centimeters.

D. An institution that uses inches and centimeters side by side, both designated, also independent in abbreviating.

> Case 1. Obl. sc. ½ " long on forehead 2c to R of M 2c above eyebrow. Irreg sc ½" lg in root of nose. Obl sc ⅜" lg on R cheek bone.

> Case 2. Faint obl scar 1½" lg otr R elbow; Mole on top of L shoulder. Two moles 3c apart R side of neck 3c and 6c below lobe. Mole on front of rim of L ear.

E. An institution that writes descriptions out in full, without abbreviations, but does not locate the details very carefully.

> Case 1. Scar at base of thumb front. Scar above outer corner left eye. Right side of face covered with numerous small moles. Other small moles on other portions of body.

These and many other forms of description are now in use, and the police are supposed on occasion to read them all. They must know that "cic. rect" and "straight scar" are one and the same thing; they must look out for such unexpected abbreviations as "otr" and "bel," and know that "f" stands for phalanx, and not finger. They must become familiar with inches and centimeters or with two or three kinds of abbreviation for these in the same description; yet may fail to discover the advantage as time-savers of such abbreviations as "elbo," "fro," or "scr." It is to be hoped that the present conditions will soon be improved, and that some standard be set for writing descriptions of bodily marks for purposes of identification.

The primitive use of tattooing and scarifying the body seems to be, as referred to above, a system of labeling an individual, indicating at least the tribe to which he belongs. Such a system Thomas Hariot, an early

traveler in Virginia, found in full force among the aborigines of that country, for he writes in 1590, "The inhabitats of all the cuntrie for the most parts haue marks rased on their backs, wherby yt may be knowen what Princes subiects they bee, or of what place they have their originall"; and among certain classes of the most highly civilized peoples tattooing still survives in very nearly its original use.

The almost universal tattooing practiced by our sailors in the time of the old sailing ships, aside from the fact that it was the fashion, had a distinctive value in identification, especially advisable in those following so hazardous a calling. At the present time, too, on the authority of the Associated Press (September 2, 1914) there is a considerable revival of tattooing among British soldiers, again with some identification value. There is, however, no system in the devices employed, as would be the case if identification were the main purpose, and the selection of devices indicates sentiment rather than utility. "Many bring their own designs, such as a heart with the name of a girl underneath, or two hearts, with hands clasped across, and the name of the girl. '*For King and Country, 1914,*' tattooed in colors across the chest, is one of the favorites outside of the love designs. French Tri-color and the Union Jack entwined has also been in demand."

Something similar to this appeared in later Rome, but was under Government control. Mallory states that "In the period of the decline of Rome, tattooing was extensively practiced. Regulative laws prescribed the adopted symbols which were a proof of enlistment in the ranks and on which the military oath was taken. The purpose of this ordinance, which continued in force for a long time, was similar to that which authorized the marking of slaves, since, the spirit of the people having become degenerated, the army was composed of mercenaries who, if they should run away, must be recognized, pursued, and captured.*

Quite aside from soldiers and sailors, the practice of tattooing, probably from esthetic or sentimental reasons, is far more widely practiced in the United States and Europe than is generally supposed, as the customary concealment of all parts of the body except the face and hands renders observation difficult. This fact is, however, better known to physicians, bath-house attendants, and prison officials, all of whom have the opportunity to make many bodily examinations; it may also be frequently observed on the bathing beach. It is here a singular fact, of interest to psychologists, that tattooing is especially popular with criminals and prostitutes, the practice thus seeming to appeal to those whose mental and moral defects put them more nearly on a plane with the lower human races.

*Col. Garrick Mallery, in "Picture Writing of the American Indians"; 10th. Ann. Rep. Bureau of Ethnol. Washington, 1888-1889, p. 408. This report includes much of interest on the general subject of tattooing.

This latter circumstance, the frequency of tattooing among the criminal class, furnishes an unexpected aid to police officials, giving assistance exactly where it is most needed. In a count of the police descriptions of 402 male criminals from the United States, all convicted of major crimes, 98 of them, practically one-fourth, were tattooed, mostly on the arms. The designs were selected from a wide series of conventional designs, delineated in combinations of red and blue, and executed in an unvarying style peculiar to this form of art, indicative of the faithful perpetuation of tradition among the tattooing craft. That the patterns found were evidently selected from a comparatively restricted list shows that the tattooed are quite at the mercy of the tattooer, being marked with the designs he may happen to be able to do, rather than with designs of any special significance or appropriateness.

Among the 98 descriptions were found the following designs, some subjects exhibiting more than one:

Letters and Inscriptions. Initials, of the individual himself, of a friend, of a sweetheart. Words like "Hope" or "Luck."

Sentimental or Religious. Hearts joined, pierced with arrow, bearing initials, etc.; hands clasped; cross; crucifix; gravestone with inscription, usually "To the memory of my mother," sometimes with willow tree, church, date, etc.

Patriotic. Spread eagle, American flag.

Sporting. Horseshoe, riding-whip, horse's head, crossed guns.

Amorous. Girl, head of figure; dancing, in tights, nude, etc.

Nautical. Ship, sailor, with whole figure or head alone, anchor and chain, fish.

Trade Emblems. Anvil and hammer, arm and hammer, engine with tender.

Miscellaneous. Steer's head, skull and crossbones, dagger, emblem of secret society, emblem of military organization, axes, rising sun, flower, gladiator, Indian with bow and arrow.

Although without doubt these emblems were originally devised to have some reference or appropriateness to the person decorated, there are numerous cases where such is far from the case. Nautical emblems appear on those unacquainted with the sea; tools and machines are bestowed upon those unfamiliar with work of any sort; and in one case the "memory of mother" inscription is accompanied by an impossible date, showing that the pattern had been bought, as it were, second hand!

Tattoo marks are of much practical use in the identification of bodies previously observed and described, but they are not absolutely permanent. As their removal is followed by a permanently scarred surface, and with often some ineradicable traces of the inscription, it is customary, in cases where concealment of identification is sought by the removal, to put a second and quite different tattoo over the spot, the condition expressed as "surcharging." Here the presence of a tattoo in the spot where one is expected, even though the design be unlike the one previously described, is a suspicious circumstance, and by no means excludes an identification.

In police records of a tattoo there seems no better method than a verbal description. The patterns, although limited, are yet too varied to easily classify, while they are simple enough in design to require few words in describing them. Owing to the use of a few definite patterns by a given tattooer, and also to the possibility of changing or "surcharging" a pattern, the employment of tattoo marks in identification, while often of assistance, is not final, and does not positively identify a person.

CHAPTER IV

IDENTIFICATION BY HABITS, GAIT, HANDWRITING, PREFERENCES, ACCOMPLISHMENTS, VOICE, ETC.

"*A man carries his personal trade-mark, not in his face only, but in his nervous system and muscles — giving rise to characteristic movements and gait; in his larynx — producing an individual voice; and even in his mouth, as shown by individual peculiarities of speech and accent. And the individual nervous system, by means of these characteristic movements, transfers its peculiarities to inanimate objects that are the product of such movements; as we see in pictures, in carving, in musical execution, and in handwriting. No one has ever painted quite like Reynolds or Romney; no one has ever played exactly like Liszt or Paganini; the picture or the sounds produced by them were, so to speak, an extension of the physiognomy of the artist. And so with handwriting. A particular specimen is the product of a particular set of motor centers in an individual brain.*"—*R. Austin Freeman, in* "*The Mystery of 31, New Inn,*" *p. 235. Publ. by Winston, Phila., 1913.*

THE most individual part of any man is his brain, and if it were ever possible to study the relations and connections of the twelve hundred million and more cell centers of which it is composed, and make a comparison of the same parts in two separate individuals, the truth of this statement would be strikingly apparent. But the same facts may be obtained in another way, within the reach of all; not by searching among the minute mazes of the central nervous system, but by observing the large results, i. e., what the individual muscular system does under the control of the brain centers.

The effect of training and the individuality of the motion as shown in the marvelous execution of a pianist are phenomena familiar to all. The differences in the action of the muscles are here so individual that if two or more separate performers render the same passage the critic can recognize each by the ear alone. But in the same way all the muscular actions of any individual are just as distinct, and to a large extent constitute the "personality," as we call it, of our friends and acquaintances.

To some extent the individual traits and characters here treated are employed in the usual form of police description, but in most of them nothing is said concerning these points; yet how many times we notice, not the face, but the gait, the gestures, certain striking peculiarities of speech, when the details of the face make but little impression. After

talking with a stranger one can often remember some mannerism in glance, movement, or intonation, while it is impossible to recall the shape of the nose, or even the color of the eyes.

There is certainly need of a scientific treatment of this whole matter—a bringing together and classifying the possible traits and characteristic actions due to brain and muscles, in some ways the most striking, as well as the most characteristic and individual, of all easily observed characters. A beginning along this direction is furnished by Bertillon in his Manual (pp. 202-211), under the caption, "General Characters and Sundry Information," but the entire subject, aside from handwriting, which forms a science in itself, is contained in but nine pages, and although admirable and suggestive, it is far from exhaustive. Bertillon presents here seven headings, of which the third, fourth, and fifth are of especial bearing here: I, The Neck (proportions and general appearance); II, Inclination of the Line of the Shoulders, seen from in front; III, The Attitude; IV, General Demeanor; V, The Voice and Language; VI, The Habiliment (clothing); and VII, General Impressions and Presumptions regarding the Social Status. Under IV, to take an example, he speaks of (1) the Gait, (2) the Gestures, (3) the Glance, and (4) Physiognomic Mimicry, that is, the facial expressions, based upon the use of the facial muscles. These he further expands in some detail, enumerating the usual kinds, and suggesting adjectives for each, which he evidently intends to have used as technical terms, each denoting a definite sort, or degree, of the trait under consideration. Thus, under (2) the Gait, he cites the following varieties:

very slow	*with short step*	*light*	*tripping* (*Fr. sautillante*)
very rapid	*with long step*	*heavy*	*sedate* (*Fr. posée*)

Then he enumerates the following kinds or styles of the gait as a whole, *stiff*, *measured*, *dandified*, *gawky*, *swinging*, *unsteady*, and *limping*.

Since even this much is very suggestive of the sort of thing one is to look for, and, by enumerating some of the things to be looked for, educates the faculty of observation, we have here attempted a similar analysis of several kinds of traits or characters coming under the scope of this chapter, with the hope that it may stimulate observation and suggest suitable descriptive words. It seems likely, however, that it will be hardly possible ever to use the descriptive words in an exact, technical sense, as the characters designated often represent varying degrees which run together, so that two independent observers might differ as to the exact degree present. It is then to be understood that, in presenting this classified list, nothing dogmatic or final is attempted, and it is expected that the practical worker will find opportunity to expand or revise to suit himself.

Traits and Peculiarities dependent upon the Individual Muscular and Nervous Systems

I. Habitual Motions.

(a) Connected with walking:

Short or long steps.
Bending of knee.
Toeing in, out, straight forward.
Position of arms:
Palms directed inward.
Palms directed backward.
Swinging various ways.
Hands clasped behind back.
Position of head, shoulders, body (Such as: erect, round-shouldered, stooping).
Carriage in general, other than above included.

(b) Connected with sitting:

Erect, lounging, sitting high, low.
Legs, crossed, straight.
Clasping hands behind head.
Tipping chair.
Putting feet up.
Hanging arm over back.

(c) Connected with talking:

Motionless, without gestures.
Much gesticulation.
Shrugging of shoulders.
Pounding fist on table.
Putting hand on listener.
Various peculiar gestures.
Action of mouth, nose, eyebrows, and other features.
Degree of action of face, still, mobile, nervous, expression grave, smiling, vicious, etc.

(d) Connected with clothing:

Hands in pockets.
Thumbs in suspenders, armholes of vest, vest pockets.
Hand thrust into coat.
Playing with watch-chain, rings, buttons.

(e) Connected with eating; table manners:

Peculiarities in holding and using implements.
Mouth kept open while chewing. (This phase of life especially good indication of the social status).

(f) "Habit-spasms" (spasmodic jerkings and twitchings, St. Vitus' dance): These to a slight degree are more or less common, and furnish an excellent clue to an individual, as they are practically involuntary, and very conspicuous. One must remember, however, that they are often not constant, but intermittent in their manifestation, increasing with worry, excitement, or exhaustion. Slight habit-spasms may affect the eyelids, the nose, the mouth, singly; in a more extreme case several parts are involved at once.

II. *Speech.*

(a) General manner of speaking:

Fast or slow.
Soft or loud.
Speaks little or much, taciturn or loquacious.
Speech flowing, jerky, drawling.

(b) Voice:

Quality (clear, husky, rasping, falsetto, shrill).
Pitch (high, low, alternating, up and down, monotone).
Degree of force (loud, soft).

(c) Defects in speech:

Lisping (*th* for *s*).
Other substitutions of sounds (*w* for *r*, *th* for *f*).
Stammering.*
Stuttering.*
Foreign accent (with some practice the native language of the subject may usually be learned from the accent).

(d) Style:

Grammatical or ungrammatical.
Cultured, provincial, sporting, language of slums.
Choice of words, profanity.

III. *Interests, Tastes, Accomplishments, Technical Knowledge.*

(a) Favorite topics of conversation.

(b) Knowledge or ignorance of certain subjects.

(c) Knowledge or ignorance of certain foreign languages. (This should be taken in connection with any definite foreign accent.)

(d) Skill in certain games or sports.

(e) Musical ability; skill in playing upon instruments.

(f) Artistic ability, and other professional accomplishments.

N. B. In all of these cases that concern the knowledge or ignorance of a thing, a suspect may often feign ignorance of what he knows, but can never claim knowledge of what he does not know, so long as he can be put to the test. For example, if a certain suspect is known to be an expert billiardist, and if the man detained on suspicion has also qualified at that game, he may still be held, pending further investigation, with the suspicion against him strengthened; but if, when exposed, he feigns ignorance or lack of interest, it means nothing. In the case of

*Although these two words are often used as synonyms, and applied to various types of hesitating utterance, the modern dictionaries (Standard, Webster's, Century) give to the word *stutter*, aside from that of a synonym of *stammer*, a special meaning, that of spasmodically repeating the initial syllable, especially those beginning with *b*, *p*, *t*, and *d*. Should we, for the present purpose, find it convenient to use both words as technical expressions, it would be well to employ the word *stutter* for the defect of repetition, and *stammer* for the other defects of hesitation. A typical *stammerer*, then, does not repeat initial syllable, but stops between words, and sometimes between syllables, often filling in the gaps with a prolonged vocalization like ah-ah or er-er.

denying knowledge of a language, an unexpected remark in that language may cause him to betray himself, while much will be indicated, even in opposition to his statements, by his accent, use of words, and sentence-formation. Bertillon, in his manual, pp. 207-210, analyzes, with considerable care, the varieties of accent commonly met with in Paris. This labor might well be extended.

IV. *Handwriting.*

The study of handwriting, associated as it is with forgeries, anonymous communications, and documentary evidence of all sorts, is a subject of great legal importance. In its commonest legal aspect the case concerns a suspected forgery of some sort, and the question asked is, Did a certain man write this? In the case of an anonymous communication, however, the question is a different one, namely, Who wrote this? and in this latter form seems at first to bring up the question of personal identity. Here, however, the case is unlike that treated in this book, since the object of study is not the man himself, or his remains, but something done by the man; not, Who *is* this? but, Who *did* this? At the same time such a case involves bodily characteristics, those of the nervous and muscular systems that performed the work, and is thus as much an indication of an individual personality as is a characteristic gesture or method of speaking. It is also possible, where the range of possibilities is not large, to use the handwriting of a man under observation, even though it be disguised, as evidence of his identity.

More than any other single gesture or habitual pose, a man's natural handwriting is the product of what he has experienced, learned, and practiced repeatedly, mind and body co-operating in every stroke. "Free, natural writing is the almost unconscious visible expression of firmly established muscular habits based on fixed mental impressions of certain forms or outlines. These muscular habits, as well as the mental patterns, differ in a marked manner in different individuals, and this variation radically affects the visible result."*

It is because of this intimate association of the movements made in writing with each individual writer that a forgery, made with whatever care, can usually be detected by an experienced examiner. If an original stroke was made rapidly by one accustomed to make that stroke, it can be successfully reproduced in no other way, and no copyist, whose experiences and training are also individual, can make an exactly similar motion. But, allowing that by an extraordinary amount of skill and practice a

*Albert S. Osborn, in his "Questioned Documents," p. 106. This is a standard work on the examination of documents, and includes an exhaustive treatment of the subject of handwriting. It is published by the Lawyer's Co-operative Publishing Co., Rochester, N. Y., 1910.

forger may succeed fairly well with the first stroke, there will come, in the course of an ordinary signature, a second, a third, and even a fiftieth; and if he stops to take breath between the strokes in places where the original writer did not, that, too, will betray itself to the expert, aided by the microscope and the camera.

In short, a man acquires certain "pen-habits" or "writing-habits," as they are variously called, so numerous and so instinctive that, in spite of himself, although he may purposely avoid the more obvious ones, others will be sure to appear, and in the course of a considerable amount of writing, like the body of a usual letter, such individual features are obvious to all. He makes a certain stroke a certain way, or at a certain angle, due to the mechanism of his hand and the training to which it has long been subjected; he lifts his pen before certain letters, certain loops or curves bear a certain proportion to certain others, and so on. A man finds it fully as difficult to write exactly like any other man as he does to walk like him or speak like him, and in imitations of both of these, although laughable similarities may sometimes be accomplished, they are seldom really deceptive. A forgery made over a previous tracing is oftentimes less successful than one executed free-hand, for it lacks all the boldness of an untrammeled motion, and the forger needs to pause, or remove his pen, from time to time, often in unusual and unlikely places, in order to see the line he is following.

Summarizing, then: an expert, acquainted with the pen-habits of a given individual, might use a forged handwriting to identify the forger with about the same degree of probability as in a case of identification by any other series of complex individual motions or habits.

Concerning the identification value of all the traits included in this chapter, it must be understood that, taken by themselves, no one of these would be sufficient for positive *identification.* Rather are they of use, and often of very great use, as a means of *recognition*, especially in the case of a fugitive from justice who does not wish to be recognized. We all know the startling recognition value of a voice with which we have once become familiar, and we occasionally have cause to recognize a man by his gait, his gestures, or his little personal habits or tricks, especially those of the facial muscles. A correspondence of a number of these would naturally strengthen a claim to identification, and, taken together with other known facts, would serve as corroborative evidence, at times very persuasive, but they are none of them tangible evidence, as are the moles and scars of the preceding chapter, and even with these, unless there are too many coincidences, that is, too many markings that correspond, the identification is not absolute.

On the other hand, these traits are peculiarly individual; it is impossible to disguise them or cover them up for long, and they are thus

of the utmost importance for purposes of recognition. They should therefore be more largely employed in police descriptions, especially in posted handbills, instead of, or at least in connection with, a description of the clothing, the details of hair and beard, and the usual photograph. It has been shown above how completely one may alter his facial appearance, and how unlike different photographs of the same man may be; beard and clothing are alterable within a few minutes; but if a man is left-handed, toes in, stoops, stutters, or talks in a husky falsetto, it is not within his power to change or modify for long any one of these conspicuous characters.

CHAPTER V

IDENTIFICATION BY BODILY MEASUREMENTS, AND BY THE FEATURES OF THE HEAD AND FACE; THE BERTILLON SYSTEM

"*And there came out a champion out of the camp of the Philistines, named Goliath, of Gath, whose height was six cubits and a span.**

And he had a helmet of brass upon his head, and he was armed with a coat of mail; and the weight of the coat was five thousand shekels of brass.

And he had greaves of brass upon his legs, and a target of brass between his shoulders.

And the staff of his spear was like a weaver's beam; and his spear's head weighed six hundred shekels of iron: and one bearing a shield went before him." — *I Samuel: XVII, 4-7.*

BEGINNING early in the Nineteenth Century, and based upon certain suggestive work of the last years of the Eighteenth, there has developed the Science of Physical Anthropology, which has for its goal the study of the bodily characters of the various human races, as a zoologist or botanist studies the varieties of a domestic species of animal or plant. This study involves a large amount of measurement, both of the living body and of bones, especially the skull, and in this latter field the researches include the excavated bones of past, and even prehistoric, races. It is not our purpose here to enter further into the scope or results of this interesting and vitally important science other than to give a brief exposition of *its methods,* a subject directly concerned with the work of this chapter.

The observational part of the science consists of carefully recorded facts concerning great numbers of living individuals, of skulls, of other bones, and of other anatomical data, such as muscular variations, and is to a large extent a study of measurements or *anthropometry.* Thus, for the skull 32 separate measurements were adopted in 1906 by the International Congress of Anthropology, at the meeting in Monaco, and recommended for universal use, and in 1912 the same body, assembled at Geneva,

*According to our system of measures this man was nine feet and nine inches tall (Bertillon height 2.97.2), and he ought to have weighed 784 pounds. It would have been of the greatest interest to have measured this man according to the Bertillon system. A man who was able to wear a coat of mail weighing 184 pounds, in addition to other weights, and who could handle a spear with a head weighing 22 pounds, would be in a class by himself.

adopted 49 definite measurements for the living body, and in both cases the measurements adopted were taken from a much larger number, which had been used by investigators for many years. The number of measurements used by individual anthropologists is usually much greater than that, and include other bones besides the skull. Thus Koganel and Osawa in 1900, in their work on the pelvis of the Aino and the Japanese, used 37 measurements for the pelvic bones (ossa innominata and sacrum), and 16 for the pelvic region of the living.

As seen by the dates, the investigations used here as examples are comparatively modern, but even fifty years ago, before the science of anthropometry had progressed as far as at present, many measurements were taken, both of bones and of the living, the purpose being that of a detailed comparison of the different human varieties, on the same basis as the work of the zoologist, who thus describes and differentiates the varieties of an animal species.

It was in March, 1882, when a young French anthropologist of twenty-nine, Alphonse Bertillon, conceived the idea that certain of these anthropological methods, which gave so minute and particular a description of a given human individual, would be much more accurate when applied to a criminal than the usual police descriptions; that certain measurements, of those which he had been trained to use for the purpose of a scientific description, and for the taking of which accurate instruments had already been invented, would serve to identify a given individual with considerable precision, provided his measurements, previously taken, and in the hands of the police, were available for comparison.

This idea of Bertillon made instant appeal to the authorities, and in 1882 a new institution, the Identification Bureau, was established at the police headquarters in Paris, and the young anthropologist, then twenty-nine years old, was called to the head of it, for the purpose of introducing and developing his system. Three years after that, in 1885, he published an account of his system in a small book of 95 pages, preparing it primarily for the International Prison Congress, meeting that year in Rome. The large second edition, practically a new book, as it contained over 300 pages and was accompanied by an explanatory atlas, appeared in 1893, and this, the permanent edition, is the one which, translated into many languages, has served to introduce his system into other countries. The American edition, in English, appeared in 1896, translated under the supervision of Major R. W. McClaughry, then Warden of the Illinois State Penitentiary at Joliet, Illinois, and at the time of his retirement in 1913 Warden of the United States Penitentiary at Leavenworth, Kansas. As *Chief of the Judicial Identification Service of France*, his official title, Bertillon retained the position created for him, continually improving his system, until his death, February 13, 1914, at the age of 61. As proof of his broadmindedness

and disinterestedness, holding as his first object the cause of identification, to which even his own system was secondary, he adopted rather recently the system of identification by finger prints, devised by Sir Francis Galton, and added it to his own, finding a place for certain finger-print records on his "Signaletic Cards." The openness of his mind in this instance is especially shown by the fact that in his earlier writings he was not favorably disposed toward the use of finger prints, and wrote in 1893: "Unfortunately it is quite undeniable, notwithstanding the ingenious researches conducted by M. Francis Galton in England, that these designs do not present in themselves elements of variability sufficiently trenchant to serve as a basis in a collection of many hundreds of thousands of cases."*

By the irony of Fate, and as a sad comment upon popular wisdom, Bertillon is commonly supposed to have been the inventor of the finger-print method, or at least to share that honor with Mark Twain, who chanced to use a thumb mark in his "Pudd'nhead Wilson." All the painstaking work of Galton and his predecessors go for nothing in popular estimation, which finds it easier to concentrate all the great achievements of humanity upon a single person, and thus be relieved of the burden of learning so many names. Bertillon achieved sufficient honor by devising and establishing the first scientific system of identification; Francis Galton, on the other side of the English Channel, devised another; Mark Twain, working in a very different field, found the opportunity to instruct the people and bring to public notice the physical basis upon which the Galton system was founded.

Bertillon's complete system, as it appeared in 1893, included the old, descriptive methods under two heads: (1) *Descriptive data* (*Signalement descriptif*), under which he included such points as complexion, color of hair and eyes, shape of nose, ear, and face, and so on, and (2) *Special bodily marks* (*Signalement au moyen des marques particulières*), which included moles, scars, tattoo marks and the like. To these he added a third, his own particular system, that of (3) *Bodily measurements* (*Signalement anthropometrique*).

For the purpose sought he employed only measurements which depend on skeletal parts; which are, therefore, practically unchanging after maturity, and unaffected by increase or decrease in weight, muscular exercise, or other conditions. The measurements selected to form the basis of his system are the following:

I. Measurements based upon the entire body (*Mesures relevées sur l'ensemble du corps*).

*"*Malheureusement il est tout aussi indeniable, malgré les recherches ingénieuses poursuivies par M. Francis Galton en Angleterre, que ces dessins ne présentent pas par eux-même des éléments de variabilité assez tranchés pour servir de base à un répertoire de plusieurs centaines de mille cas.*" Instruc. Signaletiques, 1893; Introd. p. xvi.

Standing height (*Taille — hauteur de l'homme debout*).
Arm reach (*Envergure des bras*).
Sitting height (*Buste — hauteur de l'homme assis*).

II. Measurements based upon the head (*Mesures relevées sur la tête*).
Length of head (*Longeur de la tête*).
Breadth of head (*Largeur de la tête*).
Length of right ear (*Longuer de l'oreille droite*).
Cheek breadth; bi-zygomatic breadth (*Diamétre bizygomatique*).

III. Measurements based upon the extremities (*Mesures relevées sur les membres*).
Length of left foot (*Longeur du pied gauche*).
Length of left middle finger (*Longueur du doigt médius gauche*).
Length of left little finger (*Longueur de l'auriculaire gauche*).
Length of left forearm and hand, to tip of extended middle finger (*Longueur de la coudée gauche*).

In his book of 1893, Bertillon uses as the 7th measurement the breadth of the right ear, which conveniently follows the length of the same part, but he soon substituted for this the bizygomatic breadth (or width), that is, the greatest breadth across the face, with the points of the calipers placed upon the zygomatic arches, which continues the cheek bones to the ears. This measurement, usually under the name of "Cheek breadth," is now used almost universally and appears thus upon American signaletic cards, occupying the place of the ear breadth, for which it is substituted.

Each of these eleven measurements is subdivided into three groups: *small*, *medium*, and *large*, (*petit*, *moyen*, *grand*), not according to the judgment of the observer, but in accordance with fixed limits, the result of much experience in measurements, and designed to divide an average set of measurements into three approximately equal divisions, rather than to divide equally the total range of millimeters between the two extremes. Thus, to quote an example furnished, "the numerical limits of the *medium* head-length, as used at the Prefecture of Police in Paris, include an interval of but six millimeters (185-190), while those included under *large* extend from 191mm to the greatest dimensions possible, an extent of more than three centimeters (=30mm)."*

Now, if each one of these eleven measurements has an equal chance of falling into any one of the three divisions, the total number of combinations, and consequently of subdivisions, under which the eleven data of a given individual might fall would be naturally the 11th power of 3, or 177,147; that is, a few moments' scrutiny of the eleven Bertillon measurements of a subject would assign him definitely to a certain one of over 170,000 compartments, where, in a collection of a million signalments, if the distribution were approximately even, there would be about ten

*Bertillon; Introduction, p. xxii. (Translation from the original.)

other records. These could then be easily looked over and compared with reference to other data, aside from the measurements.

To explain further, Bertillon supposes a bureau containing 90,000 descriptive cards, a number corresponding approximately to that of the adult male prisoners recorded in the Paris prisons up to 1893. Of these the first subdivision is made by the *length of the head*, and, as the subdivisions of this into *small*, *medium*, and *large* are limited with the definite purpose of insuring an approximately equal division, approximately 30,000 records would be found in each group. Each of these subdivisions is now divided again into three approximately equal parts by the *breadth of the head*, a division which leaves perhaps 10,000 in each of the nine groups thus formed; that is, there will be in each of the nine compartments some 10,000 individuals in which both the head length and head breadth fall into the same categories. The third division, based upon the *length of the left middle finger*, by dividing each of the previous nine into three, makes 27 compartments, with about 3,300 in each; and the fourth, based upon the *length of the left foot*, again multiplies the subdivisions by three, and yields 81, with 1,100 in each. But even eleven hundred signalments are too many to be conveniently compared with a given case, and the *length of the left cubitus* (forearm and hand) is next used, giving 243 compartments, with a few more than 350 in each. By the addition of the *total height*, the subdivisions become 729, with about 130 in each, and, if this is found too large for convenience, the subdivisions may become 2,187, with 42 in each subdivision by the use of the *length of the left little finger*.

This same plan of subdividing could continue, if desired, by using the remaining four measurements, one after another, but when a group is reduced to forty or fifty it has been found more convenient and expeditious to rely upon quite different data, such as the color of the eyes and hair. With each bureau it becomes a question only of the total number of signalments to be classified, and the size of each ultimate group found to be the most convenient. The number of compartments is always that power of 3 which corresponds to the number of measurements employed, which may be easily calculated by the reader, or can be ascertained from the following table. In a definite case, divide the total number of cases to be classified by the number of subdivisions at any stage in the classification, and the result will be the number of cases left in a compartment, when the classification stops at that stage.

Using 1 measurement the total number of compartments is	3 (3^1)
Using 2 measurements the total number of compartments is	9 (3^2)
Using 3 measurements the total number of compartments is	27 (3^3)
Using 4 measurements the total number of compartments is	81 (3^4)
Using 5 measurements the total number of compartments is	243 (3^5)
Using 6 measurements the total number of compartments is	729 (3^6)

Using 7 measurements the total number of compartments is 2187 (3^7)
Using 8 measurements the total number of compartments is 6561 (3^8)
Using 9 measurements the total number of compartments is 19683 (3^9)
Using 10 measurements the total number of compartments is 59049 (3^{10})
Using 11 measurements the total number of compartments is 177147 (3^{11})

This table will indicate at once to a given station how far it is necessary to carry the classification, for one may easily select the number of separate compartments desirable for the number of cases that need to be recorded and classified. Thus, if a station has 3,000 cases, the use of the first four

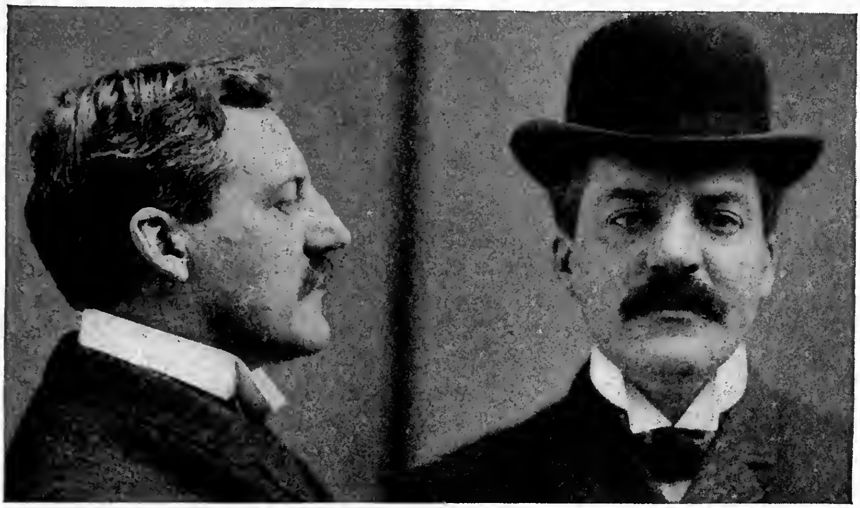


FIGURE 12. A typical Bertillon photograph. Such a photograph shows the exact profile on the left and the full face on the right. This example shows also the practice, in some places, of presenting the first bareheaded, and the second wearing a hat or cap. This is to be strongly recommended, as a man looks so differently under the two conditions, and is likely to be found either way. The best size of such photographs, for Police work in general, is one-fifth natural size, as given here.

measures (head length, head breadth, length of left middle finger, and length of left foot) will probably be sufficient, since it will give 81 separate compartments, averaging 37 records in a compartment. In a small station with 1,000 cases, the use of only the first three (head length, head breadth, length of left middle finger) will be sufficient, since it will furnish 27 separate compartments, each having an average of 37 separate cases. It might, however, be more convenient to use the fourth measure (length of left foot) and get 81 compartments, each with 12-13 cases, which would give greater ease in finding a given case.

With occasional modifications, the Bertillon system has been intro-

duced officially in the majority of the civilized countries of the world, including England, Russia, Belgium, Switzerland, the United States, and most of the South American republics; but the governmental acceptance of a system does not mean an extensive practical use. The metric system of weights and measures has now this many years been "accepted" by the United States Government, but carpenters and shopkeepers still universally use inches and ounces as though the metric system had never been invented. They go on clogging up their calculations with vulgar fractions, they burden themselves with complex reductions from inches to feet, and from ounces to pounds, dividing or multiplying by 12 or by 16, or even, in land measures, by $16\frac{2}{3}$, when with the use of the metric system all fractions would be decimals, and all reductions would be accomplished in an instant by simply shifting the decimal point.

Fortunately matters do not stand as badly with the Bertillon system as with the metric, for in all of our larger institutions Bertillon measurements are taken, and placed upon descriptive cards accompanying the two photographs (front and side), (Figure 12). The verbal description, the "marks and scars," and other matters, are placed on the reverse. There is, however, a great amount of variability in the way in which the Bertillon data are presented, so that the method employed by each institution must be learned before using the measurements. For this a few illustrations will suffice, taken directly from recent descriptions from large state and United States institutions.

The two first presented are the most complete and give the designation of each of the 11 Bertillon measurements. One of these gives also an equivalent in inches for the total height.

BERTILLON MEASUREMENTS

Height	1 M 80.0	Cheek	14.4
Out Arms	1 M 85.0	Ear Length	6.1 +
Trunk	96.0	Left Foot	26.6
Head Length	19.0	Left Middle Finger	11.8
Head Width	15.5	Left Little Finger	9.1
		Left Forearm	48.3

BERTILLON MEASUREMENT

Height 1m. . .70.2	Head Lgth. . . .17.0	L. Foot 25.0
5 feet $7\frac{1}{4}$ inches	Head Wdth. . .15.2	L. Mid. F. 11.3
Outer A., 1m 75.0	Cheek Wdth. .13.7	L. Lit. F. 8.5
Trunk 90.2	Lgth. R. Ear 5.9 +	L. Fore A. 46.0

More usually, as in the next illustration, no designations are given, which perhaps would not be necessary if all 11 measurements were always given, but this is not the case. In the first of these two examples the 11 measurements follow one another in the usual manner, but in the second one finds but ten, and, unless the system is well known, it takes

BERTILLON MEASUREMENTS

1.74 3	1.52 0	88.7	19.9	15.7	15.0	6.3	27.4	12.2	9.1	50.0

BERTILLON MEASUREMENTS

1.58 5	1.65 0	18.8	18.3	15.0	5.3	24.5	11.5	9.2	44.4

some time to preceive that the missing number is the cheek breadth, which should be the sixth. Naturally, it is not always possible to obtain a complete set of the Bertillon measurements, but when omissions are necessary they should be indicated. The next case gives a suggestion on this point, where blanks for the omissions are retained and the omissions indicated by stars.

BERTILLON MEASUREMENTS

1.67.5	1.78.5	87.0	6.3	20.3	15.3	13.8	6.3	3.2	23.9	11.6	9.4	47.9

BERTILLON MEASUREMENTS

1.68.0	1.70.0	89.0	*	18.6	15.0	*	6.7	*	24.2	11.3	8.5	44.9

The next is particularly bad, as the reader may see without further explanation.

BERTILLON:—1.60.1; 1.64; 85.2; 18.6; 15; 13.5; 6; 23.2; 10.7; 7.9; 43.2

BERTILLON:—1.71.8; 1.85; 90.5; 19.1; 16; 12.5; 6; 26.8; 11.5; 9.3; 46.

The two following illustrate a more or less common practice, that of leaving off the designation of the meter (1) in the numbers indicating total height, and arm-reach, the first two. Of course this makes no real difference to one who is accustomed to the method, but it introduces a new variety, and aids in the bewilderment of the average policeman or sheriff, trying faithfully to understand and use a system comparatively new to him. Even such a little thing as the use of hyphens instead of periods in one of these last examples adds to the confusion, besides being a naive attempt to introduce a brand-new system of writing decimals, a rather daring feat.

MEASUREMENTS

80.9	20.0	25.5
	15.7	11.6
84.	14.3	9.4
97.2	6.1	47.8

BERTILLON

70-3, 77-0, 88-0, 19-4, 14-6, 13-8, 5-4, 25-3, 11-1, 8-7, 47-1.

Aside from all these, Bertillon's early substitution of the cheek breadth for the ear breadth, although a change very much for the better, has in some quarters added further to the confusion, and the latter will still be occasionally found in a record, either substituted for the now usual cheek breadth, or, as also occurs, added to the other 11. Its value is so much less than that of the cheek breadth that the two are easily distinguished, yet it introduces still another element of possible confusion against which one must constantly be on his guard.

The introduction of the Bertillon system in December, 1882, created an actual revolution in the recognition of criminals. During the first full year of operation, 1883, 49 individuals, who persisted in the use of false names, were positively identified, and in the second year, 1884, the number of such was increased to 241. The number of such identifications increased continually, 425 in 1885, 550 in 1888, and 680 in 1892, so that criminals began to realize that attempts at concealment under an alias was useless, when pitted against the resources of scientific anthropology. For classification purposes, for example, finding the card corresponding to a given man, Bertillon has always used the 11 measures, or as many of them as were necessary, as described above; but he incorporated also, as a definite part of his system, a careful description of obvious facial characters. These are treated in his manual under the following heads:

I. Chromatic (color) characters:
   - Color of the eyes.
   - Shades of the beard and hair.
   - Complexion.

II. Morphological (form) characters having special headings on the signaletic card:
   - Forehead.
   - Nose.
   - Ear.
   - Build (breadth and girth).

III. Morphological characters having no special headings on the signaletic card:

   Supplementary features of the profile.
   - Lips.
   - Chin.
   - General contour.

   Supplementary features of the face (seen in full):
   - General contour.
   - Insertion of hair, its abundance, etc.
   - Beard.
   - Eyebrows.
   - Eyeballs; orbits.
   - Eyelids.
   - Mouth.
   - Facial wrinkles.

The description is completed by the careful description of bodily marks, with the shorthand notation given above.

An important and necessary part of the Bertillon system of description is his *Atlas of Photographic Plates*, which gives the types of foreheads, noses, chins, ears and so on, illustrating the words which he uses as technical terms in describing them. As these terms are in the French language, and as it frequently happens that French and English adjectives are not exact equivalents, the work of preparing an English edition was very great. This has been so skilfully done in the McClaughry edition that we have in it a standard for people of the English tongue quite the equivalent of the French edition. *It must be insisted upon, however, that, in following the system, one should not write a description in the words which may happen to come to him, but should use each descriptive word exactly as defined and illustrated in the manual.* Any other use of words would be liable to be inexact, and to one skilled in the Bertillon system would be positively misleading.

In Bertillon's first division of the descriptive part, that of chromatic characters, which includes the color of the eyes, hair and skin, the anthropologists, who, although working for another purpose, are as insistent in their demands for accuracy of description, have developed a system which is a decided improvement on that of Bertillon, and one which may be well introduced into police circles of this country. They have prepared *standardized sets of samples*, one for eyes, one for hair, and one for skin. The first contains a set of 16 standardized artificial eyes, arranged in order, from the darkest to the lightest, and numbered consecutively. The whole is enclosed in a strong box of japanned metal, and may be easily transported without fear of breakage.

The set of standard colors for the hair consists of 30 samples made of silk threads, the samples arranged in a row upon a metallic base, and consecutively numbered. The skin color samples are made of a sort of porcelain glass, and will not fade. They number 36.

These three sets of standard colors, devised for the purpose named, are now in use by anthropologists all over the world, and would be most convenient for the use of police bureaus. The Eye table was prepared by the Swiss anthropologist, Rudolf Martin; the Hair table by Eugen Fischer of the University of Freiburg, and the Skin table was the work of the anthropologist of the University of Berlin, von Luschan. All three are sold by P. Hermann, Scheuchzerstrasse 71, Zürich, Switzerland. The price is moderate.*

Without seeming ungracious to a system the advantage of which over all previous systems has been universally recognized, and to one the

*Eye table, $15.00; Hair table, $6.50; Skin table, $2.50. The duty is extra.

thoroughly scientific principles of which reflect so much credit upon the deviser, it is yet necessary here to consider the defects of the Bertillon system. Some of these are incident to any system which human ingenuity can devise, and most of them have already been foreseen, acknowledged, and corrected so far as possible by M. Bertillon himself. The following may be enumerated here:

1. The system is limited to the period of adult life, between the ages of perhaps 20 and 65. This is obviously because of growth up to maturity and senile changes in late life.
2. There is often considerable disparity between the measurements of the same individual, as taken by two different operators, or by the same operator a second time.
3. For the purpose of dividing a given measurement into approximately equal groups Bertillon fixes definite limits for the three groups, *small, medium* and *large.* These limits are based, however, upon the measurements of Frenchmen, and thus would not apply as well to subjects taken from other nations. If an American city, for instance, had to deal with a large number of cases, it would be necessary to assign different arbitrary limits to the sub-divisions, small, medium, and large, in order to insure an equal division.

Concerning these objections in detail, the first is of no great importance when dealing with criminals only, as the period of criminal activity generally falls within the limit during which the measurements are constant. As a system for the general identification of all citizens, however, where many of the identifications would concern children and the aged, the system would be valueless.

The second objection has been well anticipated by Bertillon himself, who has carefully noted the usual percentage of error to be expected on the part of an expert operator, in the case of each measurement, and has published the following table, which should always be at hand, or well in mind, when comparisons are made. The first column (A) gives the probable deviation upon either side of the exact truth occurring in a series of expert measurements of the same subject; the second (B), by doubling the first, gives the range, upon either side, beyond which the error is grave, while by doubling this again (C) the total range of probable error is reached, beyond which "one is justified in declaring non-identity."

Concerning the normal percentage of error to be expected, Bertillon says, "It is almost impossible, for example, to obtain twice over the same set of millimetrical figures for the height, the trunk, and the width of ear," and to this he adds in a footnote, "Thus falls the popular argument which consists in enlarging upon millimetrical differences in the height, the trunk, the ear, the forearm, etc., to prove the non-identity of two signalments. The question here is to know, not whether there are differences (*since it is impossible that there should not be some*), but how great they are, and es-

pecially whether they do not exceed the limits of necessary approximation." (Bertillon: System of Identification, Engl. transl. p. 24.)

Measurements	A Approximation theoretically requisite (in + or in —)	B Discrepancy beyond which GRAVE ERROR begins	C Mistakes of a very serious character, or discrepancies beyond which one is justified in declaring non-identity
Height	7mm.	15mm.	30mm.
Arm reach	10	20	40
Trunk	7	15	30
Length of head	0.5	1	2
Breadth of head	0.5	1	2
Length of right ear	1	2	4
Breadth of right ear	1.5	3	6
Length of left foot	1.5	3	6
Length of left middle finger	0.5	1	2
Length of left little finger	0.75	2	3
Length of left forearm	1.5	3	6

As concrete examples of the validity of this objection we present two sets of cases; one, where the same man has yielded very unlike sets of measurements at different places and times, and the other, where the measurements of different men are quite within the percentage of expected error in the measurements of a single individual. In this latter case, however, the descriptions would be differentiated by such characters as the color of hair and eyes, bodily markings and details of the features.

The first concerns one "Portland Fatty," whose measurements appear on the records of various institutions in the United States as follows:

	1899	1908	1909	1909	1912
Height	1.63.0	1.63.5	1.62.7	1.63.7	1.63.5
Outer Arm	1.73.0	1.71.0	1.74.0	1.73.0	1.73.0
Trunk	82.4	82.9	84.3	84.2	86.0
Head length	19.2	19.2	19.4	18.8	19.4
Head breadth	15.1	15.8	15.9	16.0	16.0
Cheek width	14.5	14.4		14.8	14.5
Ear length	7.0	7.0	7.0	6.9	6.8
Foot	25.9	25.4	25.7	25.9	26.0
Middle finger	11.8	11.7	11.8	11.8	12.0
Little finger	9.0	9.0	8.9	8.9	8.9
Forearm	46.7	46.8	46.7	46.9	46.8

Here it will be seen that some of the measurements of this elusive gentleman exceed the limits of error allowed by the table of Bertillon. The head length, which allows an error (including both + and —) of but 2mm., probably since it is made over resistent bone, placed near the surface, was measured in 1909 as 188 mm., and in a great police department the same year, as 194mm., a difference far greater than the limit, "beyond which one is justified in declaring non-identity." In head width, which allows the same amount of error as the head length (2*mm.*), the discrepancy of measurements is still greater, being a matter of no less than 9mm. (151 and 160).

The other example comes from Scotland Yard, and gives the Bertillon measurements of three different men, as follows:

MEASUREMENT	Robert Brown	William Bronw	J. Jenkins
Height	5'—9¾"	5'—9¾"	5'—9¾"
Outer arm (arm reach)	1.77.1mm.	1.77.0mm.	1.77.3mm.
Trunk	1.93.2	1.93.1	1.93.2
Head length	18.4	18.4	18.3
Head breadth	16.5	16.5	16.5
Ear length	6.4	6.3	6.4
Length of left foot	26.7	26.7	26.5
Length of left middle finger	11.8	11.8	11.7
Length of left little finger	9.2	9.2	9.3
Length of left forearm	46.2	46.3	46.2

In these three records several of the measurements are identical to the tenth of a centimeter, and in the case of the head breadth there is not even this difference. In no case does the difference begin to reach the limit of expected error, and the three are thus far more nearly alike than would be naturally found in two sets of measurements of the same individual; and yet they are the record of three different men, quite unlike in other details, notably the finger prints, which were entirely different from one another.

In concluding this chapter, as in the previous ones, comes the inevitable question of the actual value of the Bertillon system of measurements as a means of *positive identification*, and in view of facts like those here presented it is necessary to deny to it this power. No one should be willing to condemn a man to execution on an identification based upon a set of measurements which can vary so widely when made upon the same individual, and can be found so near alike upon different individuals. The value of "Bertillonage," as the French aptly call this system, depends upon the ease with which a man may be catalogued and classified, and

at any subsequent time traced to a pigeon-hole containing the records of a small number of individuals, among which he may be readily found.

It must finally ever be remembered that the work of Bertillon means much more than this, and does not rest upon the merits of the definite system of measurement which he inaugurated; for *he was the first to apply the scientific methods of descriptive anthropology to the identification of human individuals, and has thus opened the way for the application of other and more precise methods, for all that anthropology has to offer in this direction in the service of humanity.*

CHAPTER VI

IDENTIFICATION OF FRAGMENTARY, DECOMPOSED, OR DRIED REMAINS; IDENTIFICATION OF BONES AND TEETH

"See now to this cursed woman, and bury her: for she is a king's daughter. And they went to bury her: but they found no more of her than the skull, and the feet, and the palms of her hands . . . so that they shall not say, This is Jezebel."— II Kings; IX, 34–37.

MUTILATED or fragmentary human remains, unidentifiable through ordinary means, are usually in the form of (1) burned bodies found in the ashes of a conflagration; (2) decomposed bodies taken from the water, or found in the woods or other unfrequented places; and (3) bodies, or fragments of bodies, torn by explosion or victims of cannonading. Occasionally, too, though rarely, a question comes up concerning the identity of a buried body, disinterred after a longer or shorter period of burial, embalmed or not, and presenting in the extreme case nothing but the bones, or bone fragments. To these may be added the fragments or traces resulting from some very unusual method of disposing of a body, as in the Webster-Parkman case at Cambridge, Massachusetts, in 1849, or the Luetgert case in Chicago in 1898.

Each case of this kind presents a distinct problem, the questions before the examiner being: Is there something here which may give information concerning the individual whose remains are here presented? Can the organized and formulated body of facts constituting the science of anatomy, including its specialized subdivision of physical anthropology, and dealing with every detail of the physical body, yield any data which may assist in an identification?

Naturally, the completeness and detail of such information depend ultimately in each case upon what remains are still present, but the interpretation of the data depends upon the knowledge and patience of the examiner. As set forth in detail in Part II of this work an absolute identification is possible with even a small fragment of the skin from a palm, a sole, or a finger, but in order to do this the examiner must have in his possession a print, or at least some record of the surface found, with which to compare it. The arrangement of the hair on the surface of the body is oftentimes markedly characteristic, and in cases where there is any official record of this, or where a good account may be obtained from some associate to use in comparison, an almost absolute identification may

be expected. Among the bones, the skull is the most characteristic, as it conditions, with considerable precision, the features of the external head and face. (See Chapter VII.) The teeth, too, are among the most durable parts of the entire body, and if the subject has been much under the care of a dentist, the dental records are usually available, by a comparison with which an absolute identification is at times possible.

These parts, the palms, soles, fingers, and, to a lesser extent, the skull, furnish the material, and the only material, according to our present knowledge, from which an absolute identification can be made, and it is thus a little singular, as Sir Francis Galton has already pointed out*, that in the case of the body of Jezebel, which was said to have been unidentifiable, precisely those remains were left, and only those, upon which an absolute identification could be based.

It is to be also noted that it is by no means necessary to have large portions of a body, entire bones, or large areas of friction skin, but that to the trained observer often a mere fragment may furnish definite and valuable information. One of the most important sources of information for the archeologist is found in the "kitchen middings," or refuse heaps, left by prehistoric peoples, and consisting of bone fragments of the animals eaten, shells of molluscs, broken pieces of pottery, and occasionally a lost implement of stone or bronze. From these, numerous details of the life and living can be obtained, so that an almost complete picture of prehistoric times may be reconstructed; yet the work involves the determination of countless small pieces of poorly preserved bone and includes not only the determination of each bone as to position in the skeleton, but the particular species of animal from which it was derived.

After long experience with this sort of work, a determination involving human bones alone becomes a comparatively simple problem, and in some cases both age and sex can be estimated with a fair amount of certainty in a fragment that would convey absolutely no meaning to the untrained. In an important case one must not overlook the smallest fragment, as even the "ashes" from the crematory may possibly yield important information.

While it is utterly impossible in one short chapter to present an exhaustive treatise on the subject, it is yet possible to explain the general principles involved in the more usual cases. It may here be emphasized that expert testimony in this field, as in all others, should be capable of a full and simple explanation, easily comprehended by the "man in the street," and that all general impressions the basis for which the examiner cannot explain, as well as all technical language which cannot be simplified, should be discounted.

I. *Identification of Remains from Friction Skin.* This is the technical

*Galton; Publ. by MacMillan, London, 1892, p. 113.

name of the ridged skin that covers the "under" or *palmar* surface of the hand and fingers, and the "under" or *plantar* surface of the foot, with the toes. Its main peculiarity consists in the fact that it is made up of fine ridges (not the wrinkles), which run over the general surface in approximately parallel courses, but at certain definite points form complicated loops, whorls, spirals, and the like, known as *patterns.* As every part of this friction skin is covered by these ridges, and as the ridges themselves are not always continuous lines but are characterized by repeatedly breaking, forking, or splitting in a most irregular and individual manner, and furthermore as these features remain absolutely constant throughout the entire life, and are far too complicated to make a duplication of even a single ridge probable, it naturally follows that *a small area of friction skin, no matter where taken, is sufficient for an absolute and positive identification, provided only that a record of it in the form of a "print," or some other form of accurate reproduction, has been previously made and is available for comparison.*

Now it happens that these very surfaces, covered by their characteristic ridges, are for several reasons the most likely to survive of any part of the body surface. In the first place, the ridges are covered with a thick epidermis that is naturally more hornlike than that found elsewhere, and is thus more resistent to the action of decay; in the second place, the feet are usually encased in shoes, which offer their protection; while again the hands are often clenched or left clinging to some external object or to the sides of the body, so that these important surfaces are shielded from injury. It may thus easily happen that in a charred or drowned body the face may be unrecognizable or reduced to the bone, while portions of the friction skin of hands or feet or both still remain. In all such cases, where previous records are available, a positive identification is possible.

Although as yet, out of the whole palmar and plantar surfaces of the hands and feet only that part is as yet utilized which covers the terminal joints of the fingers, some very remarkable identifications have already been made, although the area obtainable was extremely small. Thus, in December, 1911, the body of a man was found floating in San Francisco Bay. It had been in the water for some length of time and the flesh was almost gone. The only clue was that it was in the uniform of a "bluejacket." Now the United States Government takes the finger-prints of all enlisted men, including the Army, the Navy, and the Marine Corps, and if imprints from a member of either of these bodies are submitted to the Department an identification can be made. Although the fingers of this floating body were almost stripped, the naval surgeon who examined the body found a small strip of the pattern of the right index finger, and so skillfully manipulated it that he obtained a print, from which he could ascertain that the pattern was an *arch.* From others of the fingers he

obtained slight smears, and as a forlorn hope, sent the whole to Washington. The expert of the Navy Department there went to the files, containing the finger impressions of over 150,000 bluejackets, and after an hour's search identified the dead man as a coal passer, who had been missing for about

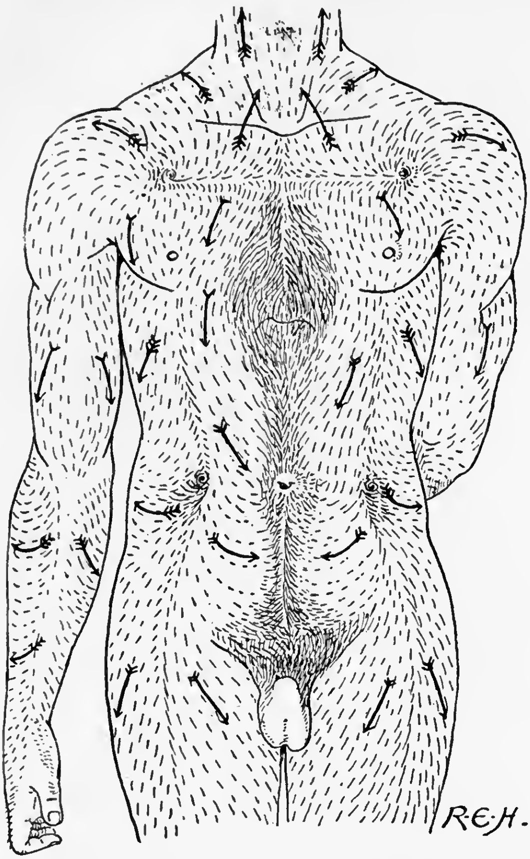


FIGURE 13. Diagram showing the more usual hair currents upon the front or ventral aspect of the trunk. (After Kidd.)

a month. The mark of desertion was expunged from his record, and a sum of money due him was paid to his next of kin.

As the second part of this work is wholly taken up with the various phases of friction-skin identification, and especially with the patterns on the balls of the fingers, to which most of the attention has hitherto been directed, the subject need not be treated further in this place, and the reader is referred there for details. It will be found there advocated,

(p. 185) that in view of the contingencies of life and the many instances where a positive identification by the usual methods is difficult or impossible, a system of palm and sole records, including the finger prints, and applied to all citizens, be inaugurated, and that these records be kept

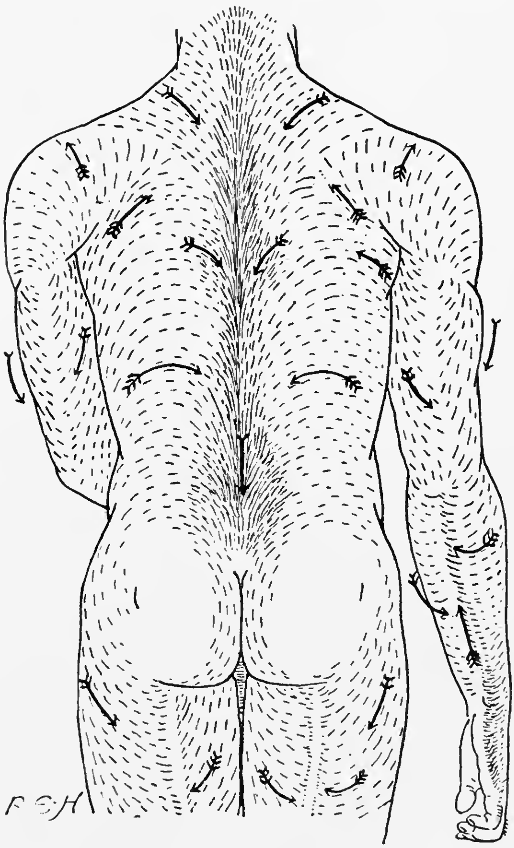


FIGURE 14. Diagram showing the more usual hair currents upon the back or dorsal aspect of the trunk. (After Kidd.)

suitably classified, in Identification Bureaus, one for each city, county, or community of convenient size. In all civilized countries every parcel of land is recorded, with all of its transfers; would it not be of equal value to record the people?

II. *Identification of Remains from the Hair Direction.* If the reader will look over the surface of a horse, bulldog, or other sleek, short-haired animal, he will see that the hair over a given area runs in a certain

definite direction, either spreading out (divergent), coming together (convergent) or parallel; furthermore, that in places there are seen special hair features, such as slightly raised lines where two opposing currents come together. *This is technically called the Hair Direction.* The surface of the human body is not hairless, as we like to think, but in the white race, at least, is often conspicuously covered, at least in places, and there are not only great differences between individuals in the amount of hairiness, and the places which are particularly so, but there is also a hair direction, as definite, though not always as conspicuous, as in the animals above mentioned. This is as true of females as of males, although in the former the hairs usually remain short and lie close to the skin, yet for this very reason the hair direction is frequently more easily ascertained in the female than in the male, where the hair is usually long and curly, and matted together. The hair direction is particularly easily studied in individuals of either sex with a sallow, white complexion and with black hair, and is much obscured in the more hairy.

In the study of hair direction, of either man or the lower animals, aside from the broad areas, which show merely a hair current running in one direction, there are the following special features, which are sometimes very conspicuous:

1. *Whorl or Vortex.* A typical vortex is seen in the crown of the head, especially conspicuous, and conveniently observed in small boys with close-cropped hair. Vortices are of two kinds, right-handed (clockwise), and left-handed (contra-clockwise) and while a given type remains unalterable throughout life, two separate individuals, or even two brothers in the same family, may show the two types. A vortex is often present on the angle of the jaw, back of the cheek, and shows conspicuously in black-haired men that have been recently shaved. Paired vortices are also to be looked for upon the front aspect of the body, halfway between the nipple and the shoulder, and again at the level of the navel, halfway out to the side.

2. *Rhomboid.* This is a little four-cornered bare area, formed by the edges of four areas, that is, two divergent areas meeting two convergent ones. The area thus left between the four is a rhomboid, having when clearly marked the exact form of the ace of diamonds. A rhomboid occurs with practical constancy on the outer margin of the forearm, near the wrist, and is often a conspicuous object in a man facing the observer, and resting with the elbow on the table and his face on his hand. A rhomboid is also to be looked for in the mid-line of the chest, below the sternal notch (fork), and on the line connecting the two lateral vortices above mentioned.

3. *Crest.* This is a line, or ridge, formed along the common boundary of two hair streams that converge gently toward each other. It is the opposite of a

4. *Parting*, which is too well known to describe. Sometimes made artificially with a comb where Nature never intended to have one, natural partings also exist in other regions. They are formed along the boundaries of two diverging currents.

There are some other features found in the study of hair direction, but the ones given are the essential ones. Upon the broad chest of a bulldog may usually be seen whorls, rhomboids, crests, and partings, all within a restricted area, and with his short, smooth coat, this animal furnishes an excellent object of study.

Were we accustomed to expose more of the body during the usual daily routine, our friends and associates, or at least one's own family, would become so familiar with individual hair peculiarities, that the study of the hair direction would become an important branch of research for the identifier. Even as it is, cases are known, notably the Webster-Parkman case, in which the identification of remains, in this case that of a dismembered fragment, was made through a peculiar disposition of the hair on the pelvic region, known to certain members of the family.

III. *Dessicated Remains; Dried Skin.* Occasionally, even after long burial, where the conditions are favorable to dessication, human remains may be found dried, so that not only ligaments and tendons remain but even portions of the skin. These sometimes include a hand, a foot, or one or more fingers, so that essential data may still be present but, in their shrunken condition, difficult or impossible to study.

These parts, including more or less friction skin, are naturally found in embalmed mummies, like those of Egypt and Peru, and are especially well preserved in the sun-dried type found in the caves of Southern Utah; it is probable, too, that the work of our modern embalmers will, when placed under favorable conditions, have a similar lasting quality. In certain kinds of places, such as the higher levels of a sandy elevation, where the water drains through quickly and does not stand, there is usually more or less drying before decay becomes far advanced, and a part once properly dried, and kept in a dry place, may last for centuries. Thus in 1913, in Warren, Rhode Island, upward of 60 Indian graves were opened up, dating from the Trade Period of the American colonies, 1625-1675. The graves were at the top of a dry, sandy hill, where water would not collect, and in several instances not only the bones, but pieces of dried skin, were found intact. The skin was, however, usually found covered with red paint, a common practice of the aborigines in that region, and this may have had a preservative effect. In some cases, too, where parts of the body had been placed in contact with copper kettles, and other copper utensils, the parts were found colored green and preserved by the action of the copper salts. This case, although of little direct application to present-day problems, is nevertheless extremely valuable in suggesting

possibilities. Another instance of preservation through the chance introduction of copper under more modern conditions was seen by one of us in excavating an Indian cemetery in Charlestown, Rhode Island, where the interments were in Christian form, with coffins, and dated between 1750 and 1840. In several cases, where pins had been used about the head, the pins were found upon the surface of the skull, with patches of hair preserved in the immediate vicinity, while elsewhere it had entirely disappeared.

In bodies left in dry woods, or hastily buried in the sand, the skin is

FIGURE 15. Sun-dried "mummy" of one of the prehistoric Cliff-dwellers, just as it was found in a cliff ruin in southern Utah.

FIGURE 16. Same as Figure 15, "restored" through the action of a weak solution of caustic potash. (See American Anthropologist, Vol. 6, 1904.)

very likely to resist decay, especially that of the hands and feet, where the underlying parts are mainly of bones and tendons, and here too, as in all instances of drying, the parts are left hard and shrunken, and difficult of examination. In all such cases, wherever dried parts are to be investigated, they may be restored to practically their natural form by simply immersing them in a 1-3 per cent solution of caustic potash (K-OH), and allowing them to remain until they have swollen out to apparently their normal fullness, after which they should be immersed in water for a short time, and then placed for final preservation in weak alcohol or a solution of formalin. When in the potash they should be watched from time to time, but a fairly large piece, like a hand or a foot, might remain

over night without harm. In general, three to twelve hours should be sufficient. The effect of the immersion in water after the potash seems to be to cause a little more swelling, and fill up places which the potash has not affected, yet this very action may become dangerous if allowed to continue too long, and at the first signs of bursting or disintegration the piece should be brought into the alcohol or formalin. This checks at once any further action, and preserves the part indefinitely. After this the part may be studied at any time, but must be handled in a pan of water, or must at least be kept moist, and finally returned to the preservative. The alcohol solution should be about half-strength, that is, one volume each of ethyl alcohol (not denatured) and water; the formalin should be about a 5 per cent solution (roughly, one part of the commercial formalin in 20 parts of water).

The advantage of thus treating a piece of friction skin is obvious, provided only that prints of the one likely to be identified are available; otherwise it has no value in this connection. There is also the possibility of finding moles, scars, or tattoo marks upon such "restored" parts; a body or part of a body may also be dissected after this treatment, and any known pathological defect searched for; and in some cases a disease may be diagnosed. Two dried bodies of Utah cliff dwellers, several hundred years old, were thus treated by one of the authors. The friction-skin patterns on hand and foot were practically as distinct as in life; and both bodies were quite satisfactorily dissected, and several points noted.*

The possibilities of microscopic diagnosis in an embalmed body, or in a dried part after treatment with potash, are very great. When Gen. Horace Porter, in 1905, excavated the embalmed body of John Paul Jones from beneath a street in Paris, for interment at Annapolis, the French pathologist, M. Papillaut, investigated the body, to make certain the identification. Among other things, he found calcified tubules in the kidneys, proving the disease of those organs from which he was known to have died. Similarly the embalmed right thumb of a Peruvian mummy, restored by the potash method, showed to one of the authors by a microscopic test a case of miliary fever, a disease which covers the skin with minute pustules, and here evidently the fatal illness of the subject, who had died before the visit of Columbus.

IV. *The Bones.* Even in badly mutilated remains, or after long burial, there are usually found some or all of the bones capable of yielding important data. The skull, with the teeth, is naturally the most valuable part of the skeleton, but there is no bone which can give no in-

*For the details of this investigation, together with more explicit directions concerning the method, the reader is referred to the original paper: Wilder, H. H. The Restoration of Dried Tissues, with especial Reference to Human Remains, in American Anthropologist, Vol. 6, 1904, pp. 1-17.

formation to the scientific investigator. From the bones alone can be determined the stature and proportions, the approximate age, and usually the sex. Diseases affecting the bones, either active at the time of death, or present at any time during life; all deformities involving the bones; and all injuries to bony parts are permanently recorded on the skeleton. It is even possible that with increased knowledge of the subject, and with the invention of suitable instruments to record the shapes and geometrical relationships of the articular surfaces of the joints, it will sometime be possible to ascertain individual peculiarities of pose or motion, such as toeing out, left-handedness, or manner of carrying the head.

For a careful and detailed study of the skeleton in respect to bodily characters the bones must be reasonably clean, and it is recommended, after every possible scrap of information has been derived from the soft parts, to have the bones prepared for study in the usual way. They are then in condition to be investigated for the following data:

(a) *Sex.* Naturally the sex of a given body can be usually determined from the soft parts, even if badly mutilated, since certain of the deepest lying internal organs may be used for this purpose when all the superficial parts are gone. Yet, where the bones alone remain, as after long interment, or even where only a few bones are present, the records of the sex are not entirely lost, provided the extant bones consist of the proper parts for such a determination.

The bones most useful for a sex determination are (1) the skull, (2) the hip-bones, (ossa innominata) and (3) the sacrum. Any one of these will in most cases furnish a fair amount of certainty regarding sex, but where all are gone, no one would venture to give more than a guess, relying upon the size and proportions of the bones.

The most conspicuous male character in the skull is found in the prominent *superciliary* (or eyebrow) ridges, in the form of rounded, slightly roughened, areas, that lie above the inner, upper corner of the orbits, often nearly in contact in the median line. Seen in different lights these often form a striking character, and give to the entire region above the nose and between the eyebrows a decided fullness, above which, in contrast, the forehead profile appears hollowed out and retreating. In the female skull, on the other hand, this region is flat; the superciliary ridges are inconspicuous, and the forehead profile above this region is full and often bulging, as in a child. The male jaw is usually broader and heavier, and the teeth are more massive. As in the rest of the skeleton the prominences to which muscles are attached during life are heavier and more strongly developed in the male, and this effect is seen in the back of the skull, where are found the median occipital protuberance, the superior curved lines, and the mastoid processes. To these prominences are attached the strong muscles of the back and sides of the neck, which hold up the head, and

as the male head averages larger and heavier than that of the female, these muscles in the male have a harder task, which develops both the muscles themselves and the processes of the skull to which they are attached. This difference is especially noticeable in the mastoid processes, which are longer and more robust in the male.

It will be seen that no one of these characters shows an absolute diffierence in the two sexes, but depends upon comparison, the male in every way showing the stronger and heavier characters, and the female the softer and less developed ones. These characteristic differences are not seen in the skulls of children, and it is noticeable that it is the male which, in maturity, develops the differences, and hence grows away from the common type from which both sexes begin, while the female, not developing these differential characters, retains more the childlike characters. As in all cases where differences are those of degree merely, a long familiarity with the work is necessary to a reliable diagnosis, but in most skulls the sum total of the characters gives the expert sufficient basis for a fairly reliable decision.

The hip-bones, taken with the sacrum, to which they are attached, and with which they form the hip-girdle, a frame that fits about the entire trunk, are the best parts for a sex diagnosis, but even here the differences are not absolute, and appear strongly marked only in the adult. When all three bones are present (the two hip-bones and the sacrum), so that they can be fitted together in their original position, the surest point for sex diagnosis is the *sub-pubic angle*, a median angle with apex up, placed below the pubic arch, and framing in the outlet for the pelvic organs. In the female this angle is widely open while in the male it is narrow and pointed. As this angle differs widely individually, the matter cannot be brought down to definite measurements, but it takes comparatively little experience to detect the difference rather quickly in typical cases. In males the angle can be as narrow as 38°, while in the female an angle of 104° has been recorded, but the usual cases are not nearly as extreme. There seem to be also racial differences, and the figures presented by different anthropologists, even among related peoples, differ somewhat. According to the most recent authorities the range of difference to expect in males of the white race is about 40° to 80°, and in females 60° to 100°. The average for males is 60°, and for females 74°.

Taken as a whole, the pelvic girdle of the female is broad laterally, and that of the male is narrow; the iliac portions of the hip-bones are broad and hollow in the female, and narrow and flat in the male; the sacrum is broader and more concave in the female. These differences are usually so pronounced that they are easily noticeable in a single hip-bone, or in a detached sacrum.

Summarizing, then, the sex diagnosis of a skeleton, the differences

must be recognized as relative rather than absolute, as differing markedly in different individuals;, and in not becoming noticeable before adult life. When pronounced sex characters are present in all the bones here mentioned, skull, hip-bones, and sacrum, the examiner is warranted in declaring the sex as beyond all reasonable doubt; when, however, they are not pronounced in any of the bones, or where the evidence of the different bones is conflicting, the determination must be treated as uncertain. Some women are masculine in external appearance, and some men are more or less feminine; in the same way the sex characters are often not pronounced in the skeletal parts; still, in the majority of cases an an-

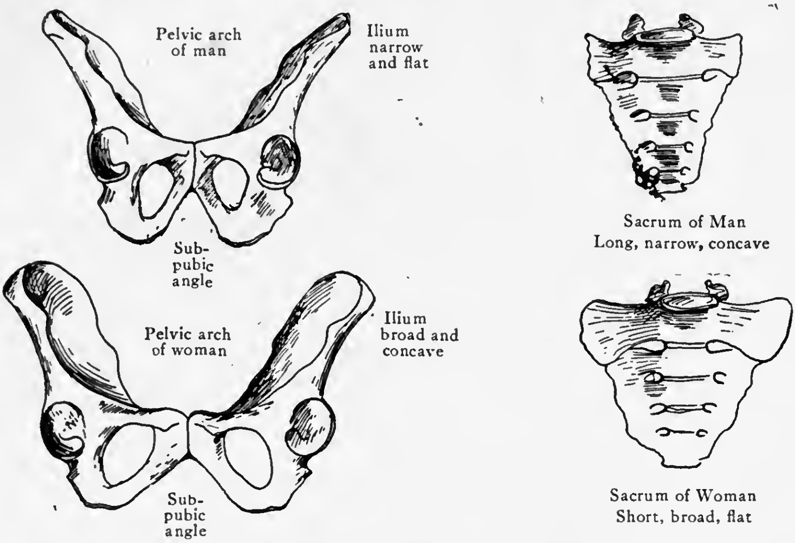


FIGURE 17. Sexual differences in the bones of the hip region. Further explanation in the text.

thropologist who has had long practice in "sexing" skeletons, can render a decision amounting to almost a certainty.

(b) *Age.* The separate bones of the skeleton, during development, run through a long and complicated history. With the exception of some of the bones of the skull, and the clavicle (collar bone) each piece is formed first of cartilage, and this yielding and elastic substance is gradually replaced by the more rigid bone, the process not being complete until the age of twenty-five or even older. This change is in itself far from simple, since the growth of bone usually takes place at several points, the *centers of ossification,* which begin their development at different times, and when, finally, the cartilage between two growing centers becomes entirely replaced and the pieces are in contact, a long time may elapse before they entirely fuse with each other.

While, now, certain of the early stages in the development of a given bone are passed in the embryo, the rest of the history extends over some twenty-five years; and as so many events in this history occur during that time, such as the appearance of a new center, the completion of the ossification of a center, the fusion of two elements, and so on, and as each of these has a certain average age at which to appear, the age of a person under twenty-five may be quite definitely calculated from the skeleton, or even, occasionally, from a single bone.

To explain by an illustration: the scapula, or shoulder-blade, of the new-born infant consists of a single piece of bone, flat and triangular in shape, and bearing upon its dorsal (rear) surface a ridge or spine. Around the edges of this the characteristic shape of the scapula is built out by cartilage, which shows, among other parts, the acromion and coracoid processes, still without trace of bone. During the first year of life a center of ossification appears in the cartilaginous coracoid process. This increases until the part becomes wholly osseous but does not fuse with the main bone until the age of 14 or 15. The acromion remains cartilaginous until the 15th year, when many little nuclei of bone appear. These unite with one another, and with the main piece, in a complicated fashion, but the individual is 20 to 25 years old before the process is complete, and the acromion is wholly ossified and firmly joined to the main part. Finally the thin cartilaginous edge along the medial (vertebral) border develops ossifications between the 16th and 18th years, which remain distinct for a time and do not unite with the rest until the age of about 25.

Here, then, is a long series of events, extended along through the first twenty-five years of life, each occurring at a fairly definite age. Such striking events as the fusion of the coracoid at 14, the appearance of ossification in the acromion at 15, and along the medial edge between 16 and 18, and the final completion of the bone, as known in the adult, at 25, give definite age limits to a bone showing such characters, and these, with the assistance of other bones, the events in the development of which come at different periods, will serve to determine the age of an individual before the final adult period. Furthermore these characteristics are exceedingly plain and conspicuous, and may be seen in a fragment as well as in an entire bone. An age diagnosis, then, apart from the material available, is mainly a question of knowledge and ability on the part of the examiner; knowledge of the details of bone development, extended to every bone of the skeleton, and the ability to recognize, not only an entire bone, but even a small fragment in a poor condition.

The most striking difference between the skeleton of a young person and that of an adult is that seen in the so-called "long bones," that is, bones which are cylindrical in shape, and long in proportion to their caliber.

Most of the bones of the arm and leg, including finger and toe bones, are in this sense long bones, while no long bones, except, perhaps, the clavicle (collar bone), are met with in either head, neck, or trunk. With some slight exceptions a long bone, of whatever size, develops in three parts, a *shaft* and two *ends*, technically diaphysis and the two epiphyses, and as extension in length depends upon addition of bone substance at the ends of the shaft, it is clear that the ends cannot fuse with the shaft until the full size is reached. In some reptiles, like the alligator, the shaft and ends never fuse, and thus each long bone, and also the whole animal, continues to grow as long as it lives; but in man there comes a time, between about 17 and 23, when the end pieces of the long bones, the epiphyses of the anat-

FIGURE 18. The bone of the upper arm (humerus) of a child, showing its composition from three pieces; the shaft and the two epiphyses, or ends. Growth in length is possible only so long as these parts remain separate. When fully grown the ends become fused with the shaft. This is true of all the long bones of the body, *i.e.*, those similarly shaped, including the bones of the arm and leg, and those of the hands, feet, fingers and toes, except the bones of the wrist and ankle. The condition of these bones gives a rough criterion of the age of a skeleton or of a single bone.

omists, which fit like caps over the ends of the shafts, become so firmly fused to the latter that no further additions are possible, and the individual is said to have "got his growth." One can tell, then, an adult long bone from an immature one by the condition of the epiphyses, and after some little experience, can make some estimate concerning the age of the latter by the degree of the attachment between the parts.

Other convenient age criteria are here shown in list form, but naturally some knowledge of bones is required in order to apply them. The last one on the list is the very last developmental change that takes place in the skeleton, and a complete fusion here marks a man as mature.

1.	Coracoid process of the scapula.	Fuses with the main bone at puberty.
2.	Sphenoid and occipital, at base of skull.	Fuse at 16th year.
3.	The three parts of the os innominatum.	Fuse by the 18th-20th year.
4.	The free upper margin of the ilium (hip-bone).	This is finished off by a thin strip that runs along the free edge. Fusion with the main part complete by the 25th-28th year.

If the examination concerns an infant or little child before the age of 8-10, there is such an abundance of data, from both bones and teeth, that a fairly reliable verdict can be made down to the year, and, during the first year, down almost to the month. For this, the best part to examine would be the skull, without which, indeed, a determination could be only approximate.

When teeth are present they give a simpler age record than do the bones, and while often a special examiner is necessary for the interpretation of the latter, any good dentist can give fairly accurate estimates from the condition of the teeth. Taking into account the twenty teeth of the first set, and the thirty-two of the second, in both of which the eruption of new teeth occurs successively and not simultaneously, and considering that the first of the permanent teeth begin to appear soon after the eruption of the last of the first set, we see that the teething process consists of a long series of events extending over the entire period from birth to maturity; presenting a convenient and exact method of determining the age of an individual. Incidentally it may be pointed out that the teeth are available in the living subject or in an undissected one, and may thus be useful in cases where a determination from the bones is not possible.

One must bear in mind, however, in all data resting upon development, whether of bones or teeth, that the dates for the events show some individual variation, in certain cases a considerable one, so that an age thus determined can be only approximate. An extreme instance of this is seen in the third molars, or "wisdom-teeth," which have a normal range between the 18th and the 28th years, but may appear a year or two earlier, or may be delayed into middle life. Here this great variability is connected with the vestigial character of the teeth themselves, that is, organs which were once of considerable importance, but are now in process of disappearance. Such parts are always extremely variable in every way, and neither in their form, size, nor development do they keep up to as definite a standard as in the case of functionally active parts, having an important function to perform.

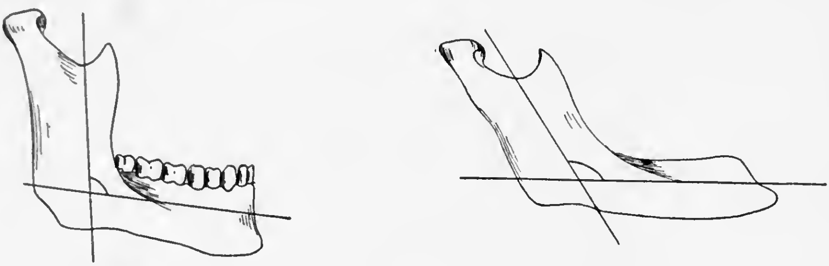
After the age of twenty-five, along through middle life, age data are not definite, and little can be done with a skeleton other than to place it within these limits. But, with the appearance of senile changes, several

characters appear that grow more and more marked as age increases and these give suggestions of the age, reliable within perhaps ten years.

The three most characteristic senile changes that affect the skeleton are the following:

1. The obliteration of the cranial sutures.
2. The spreading out of the angle of the jaw.
2. The reduction of the angle between the neck and shaft of the femur.

The three cranial sutures (Lat. *sutura*, a seam) are formed by the joining together of the edges of the bones that form the cranial part of the head. Originally five bones enter into this: two *frontals*, that cover the forehead; two *parietals*, that build the sides, and a single *occipital*, that forms



JAW IN MIDDLE LIFE JAW IN OLD AGE

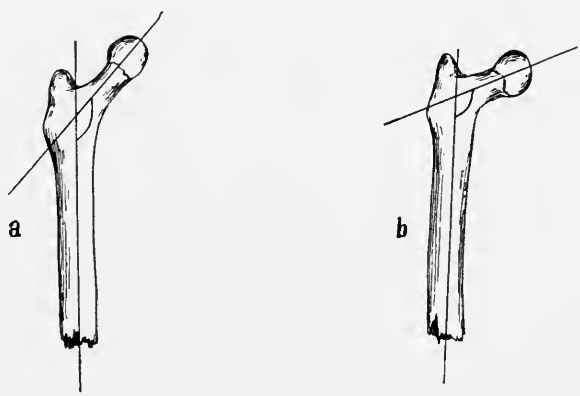
FIGURE 19. Two profile views of the human jaw bone, showing the change of angle throughout middle life and in old age.

the back. The two frontals, however, unite to form one piece at about the end of the second year, reducing the number to four. The *coronal* suture runs across the head between the frontal and the two parietals, the *sagittal* suture runs lengthwise between the two parietals, and the *lambdoidal* suture, like an inverted V, fits in between the parietals and the occipital.

In the infant the edges of all these bones are very thin and lie simply in contact with one another, but, as age increases and the bones grow, they interlock by means of fine serrations, and the sutures come to resemble the lines made by a fret-saw, looping back and forth in a complex pattern. These serrations become continually more intimate, and the interlocking parts fuse together until in advanced age there is a more or less complete obliteration of the lines between the bones, and the entire skullcap becomes a single piece. This obliteration of the sutures, although usually a sign of age, is not absolutely reliable, as some very aged skulls, where the teeth have long been lost, show distinct sutures, while an almost complete obliteration has been noticed in a skull scarcely mature.

The second character is in part the result of the loss of the teeth,

which affects the jaws mechanically, allowing them to shut farther than in youth. This change becomes still more marked, as the alveolar processes, the ridges built out upon the jaws for the insertion of the teeth, become absorbed soon after the loss of the teeth, and allow a still greater approximation of the jaws. During middle life the two parts of the lower jaw, *body* and *ramus*, are set at an approximate right angle, but the change in the action of the jaw, when it becomes toothless, causes the two parts to lie more nearly in a straight line, or, in reality, to form a single wide curve. This closing up of the jaws causes the chin to swing farther out, that is, to protrude, and this protruding chin, approximating the nose, with the mouth sunken in, is a well-known characteristic of the senile profile. The flat-



NECK SHAFT ANGLE IN YOUNG ADULT NECK SHAFT ANGLE IN OLD AGE

FIGURE 20. Two views of the human thigh bone (femur), showing the change of angle in its head and neck in the young and the old.

tening of the angle of the jaw is an internal change corresponding to the external one.

The third of the three characters most conveniently used to detect old age is the angle between the neck and shaft of the femur (thigh bone), and is illustrated in Figure 20. During youth, and continued in mature life, the neck and head of this bone, so characteristic of the proximal end, are set at a wide angle to the shaft, as in *A*, but as old age advances the head and neck become bent down and ultimately form with the shaft almost a right angle; and at the same time the neck itself becomes somewhat shorter. As the head and neck of the two thigh bones support the entire weight of the trunk and head in a standing figure there is naturally a great and almost constant strain upon these parts, and it thus seems likely that this bending of the angle in old age is directly due to the effects of this burden when the normal vigor becomes impaired. Although a

partial compensation is found in the shortening of the neck in absolute length during this process, there is still mechanically a greater strain upon the bone when the angle becomes thus reduced, and to this, as well as to the increased brittleness of the bone substance in advanced age, is due the frequency with which this neck breaks off in the aged, even as the result of a slight misstep.

There are certain senile changes in other skeletal parts, the result of the reduction in the actual bone substance, externally noticeable in the "settling-down" process in age; they are, however, difficult to define, although a very aged skeleton, or even a single aged bone, makes a definite impression upon the observer. In all this, however, one must be on his guard not to claim too much or to claim it dogmatically, since the effect of age shows individually at very different ages and acts in very different ways.

(c) *Stature and Proportions.* Inevitably the first question asked by the bystanders on the excavation of a skeleton, and in legal cases at least an extremely important one, is How tall was the person? What was his standing height when alive? Curiously enough, also, the novice always overestimates the height, when he judges from the bones alone, and considers the bones of an ordinary man those of a giant.

Fortunately, owing to the researches of the anthropologists, a long series of figures are available on this point, presented in the form of coefficients, numbers by which to multiply the length of a given bone, in order to get the total height. To begin with, a rather rough set of estimates, which can be easily applied, show that if we multiply the total length of the femur (thigh bone) by 3.7 for a man, and by 3.6 for a woman, the result will be the height of the individual. Similarly, the length of the humerus is about one-fifth that of the total height, so that its length, multiplied by 5, without regard to sex, will give a rough estimate of the height. A more careful table has been prepared by Manouvrier, which gives for each sex, in a normally proportioned individual, the length in millimeters of each of the long bones of arm and leg to be expected with a given height. This table follows on next page.

It would often be of value to work out correspondencies between the Bertillon measurements and the bones, yet for this purpose the selection of the eleven measurements now in use was unfortunate. There are plenty of anthropometric measurements, like the length of the radius, or some of the other long bones, where the result would be the same whether taken from the skeleton or on the living body, but the eleven measurements of Bertillon involve either soft parts, or a series of bones, placed end to end, where allowance has to be made, without data, for the cartilages of the several articulations. Yet, given a skeleton, it should be a comparatively simple matter to ascertain from the bones an approximate

MALES

Fibula	Tibia	Femur	Humerus	Radius	Ulna	Total Height
318mm.	319mm.	392mm.	295mm.	213mm.	227mm.	1.53.0
323	324	398	298	216	231	1.55.2
328	330	404	302	219	235	1.57.1
333	335	410	306	222	239	1.59.0
338	340	416	309	225	243	1.60.5
344	346	422	313	229	246	1.62.5
349	351	428	316	232	249	1.63.4
353	357	434	320	236	253	1.64.4
358	362	440	324	239	257	1.65.4
363	368	446	328	243	260	1.66.6
368	373	453	332	246	263	1.67.7
373	378	460	336	249	266	1.68.6
378	383	467	340	252	270	1.69.7
383	389	475	344	255	273	1.71.6
388	394	482	348	258	276	1.73.0
393	400	490	352	261	280	1.75.4
398	405	497	356	264	283	1.76.7
403	410	504	360	267	287	1.78.5
408	415	512	364	270	290	1.81.2
413	420	519	368	273	293	1.83.0

FEMALES

Fibula	Tibia	Femur	Humerus	Radius	Ulna	Total height
283	284	363	263	193	203	1.40.0
288	289	368	266	195	206	1.42.0
293	294	373	270	197	209	1.44.0
298	299	378	273	199	212	1.45.5
303	304	383	276	201	215	1.47.0
307	309	388	279	203	217	1.48.8
311	314	393	282	205	219	1.49.7
316	319	398	285	207	222	1.51.3
320	324	403	289	209	225	1.52.8
325	329	408	292	211	228	1.54.3
330	334	415	297	214	231	1.55.6
336	340	422	302	218	235	1.56.8
341	346	429	307	222	239	1.58.2
346	352	436	313	226	243	1.59.5
351	358	443	318	230	247	1.61.2
356	364	450	324	234	251	1.63.0
361	370	457	329	238	254	1.65.0
366	376	464	334	242	258	1.67.0

set of Bertillon measurements, which might occasionally be of value in identification. This would be somewhat similar to the reconstruction of the measurements from the hat, shoes, and other clothing, as has been treated, with some success, by Bertillon himself.

(d) *The Race to which a Given Skeleton Belongs.* There is a general impression, too often encouraged, perhaps, by those who wish to maintain a reputation for exact knowledge, that the skeletons of the various human races, and especially the skull, are in every case sufficiently distinct in their characteristics to render an exact verdict on the subject a matter of certainty. Now, as a matter of fact, this subject of racial differences in all parts of the body, including the skeleton, has long been one of the chief labors of the physical anthropologist, and it is possible to find certain proportions, angles, peculiarities in the different bones, and other such things, which are characteristic of a given race in the sense of their more frequent occurrence there than elsewhere. Detailed measurements, too, especially the use of these in showing proportions, often reveal quite definite racial differences, when considered as the averages embodying the results obtained from the measurements of many individuals. This is, however, quite a different thing from asserting the existence of constant and definite characteristics which exist exclusively and constantly in a given race, whereby every individual of that race may be distinguished, which is not the case.

An anthropologist who has made himself familiar with the general characteristics of the skulls of a given race would undoubtedly be able to recognize it if presented with a dozen or two skulls of the same race; there would even be some specimens in the entire collection the features of which were so characteristic and typical that he would have little doubt about them if examined singly, but there would surely be others in which the racial characters were not so definite, and the diagnosis of which would be uncertain, even to him. To state the case fairly and conservatively, a man who has had practical experience with skulls and skull measurements would usually be able to make a good diagnosis as to the race of a given skull; testimony which might prove of considerable value, but upon which, when taken alone, no final verdict should be based.

(e) *The Teeth Identification.* The value of the teeth in determining the age of a skull has already been touched upon. In cases where the teeth show the care of a dentist, they may yield results leading to an absolute identification, provided only that the dentist or dentists who did the work can be found.

Fillings, porcelain or gold crowns, bridgework and other dental work of a permanent nature, are individual pieces of work. They are performed according to the countless individual needs of the patient, and often, by the materials used, and the manner of application, give indication of

the dentist who did the work. To make such work available in identification, however, one must depend upon the testimony of the operator, and to some extent upon his memory; but fortunately, among modern practitioners, the details of the teeth of each patient are kept filed away on individual cards, which are kept up to date by the addition of each new treatment, and these may become convincing testimony as to the identity of a given body, or a given skull or skull fragment. Then, too, dentists often take plaster casts of parts of the mouth, or of single teeth, and where these are kept, would prove the absolute identity of a jaw found to correspond. In all use of the teeth as means of identification it must always be kept in mind that their condition changes from time to time, that teeth are extracted or spontaneously rejected, and that fillings and other dental work may be replaced, but it would never be possible, after the indubitable loss of a tooth, to identify with that subject one who, at a later date, was found to still possess it.

A special advantage of the teeth in identification lies in the fact that they are the hardest and most imperishable parts of the body, and might thus survive, not only long decay, but to some extent the action of fire and chemicals. Thus in the Webster-Parkman case in 1849, which involved especially the identification of fragmentary remains, a block of "mineral teeth," something like the modern bridge work, was found in the ashes of a furnace, and was positively identified by a dentist, Dr. Keep, who had made them for Dr. Parkman in 1846, three years before.

In spite of their occasional use, however, teeth have been regarded to have but little value in identification, since their use depends absolutely upon the possession of a recent dental record of the subject; yet this is precisely what can be easily furnished by the dentists in cases where the subject has come under good professional treatment. These practitioners are accustomed to keep dental charts of all of their patients, which consist of cards bearing the outlines of a complete set of teeth, upon which every detail of each tooth can be easily and quickly marked. Although such records are generally limited to definite dental operations, the full description, or signalment, of a mouth, as recently given by a specialist, who is both a practitioner and a professor in a dental college,* is as follows, the example giving both the data asked for and the detailed description of a supposed case:

Dental and Oral Peculiarities. Case No. X.

Character.	Condition in this Case.
(a) Curve of arch, whether round, square, or V-shape.	Round square.
(b) Width of arch, in centimeters — from outside surface of first upper molars.	5.8 centimeters.

*Thompson, A. H., in *Popular Science Monthly*, June, 1904, pp. 161-163.

(c) Depth of vault, from grinding surface of molars.	2.5 cm.
(d) Color and texture of gums; peculiarities of ridges in roof.	Gum reddish-pink; health line well marked; rugæ shallow and rather straight.
(e) Size of teeth, whether large, small, or medium.	Medium small.
(f) Shape of teeth, whether wide or narrow, long or short, worn or not, etc.	Rather wide and short, cusps low and rounded.
(g) Color of teeth, white or dark, yellowish, bluish of modifications, etc. (This factor would be modified by time and habits, but the expert observer would estimate that.)	Rich cream color, shading to yellowish at cervical border.
(h) Irregularities of the teeth, as to being out of normal place; crowding, and malpositions generally.	Upper laterals both everted at mesial border; right lower central crowded inward.
(i) Teeth absent totally.	First right upper bicuspid and second left lower molar missing; first upper molar broken off and roots remaining.
(j) Fillings in teeth — noting positions on crown, and materials employed.	(Fillings located on chart, numbered.) 1. Gold filling; 2, large amalgam filling; 3, cement filling.
(k) Cavities of decay unfilled.	(Cavities located on chart, numbered.) 1, deep decay; 2, shallow decay.
(l) Diseased teeth, dead teeth, chronic abscess, etc.	Dead tooth and chronic abscess and fistula.
(m) Artificial tooth crowns — porcelain, gold, bridge teeth, etc.	(Located on chart.) 1, gold crown 2, porcelain crown.
(n) Artificial teeth on plates.	None.
(o) Miscellaneous peculiarities, such as abrasion, pits or other congenital markings; lingual cingules; number of cusps on second lower bicuspids; on upper second molars, etc. Third molars, present or absent; forms of crowns, etc.; and all abnormal forms of teeth.	(Located on chart.) Third molar peg-shaped; 2, both lower bicuspids of tricuspid form; whitish spot on labial face.

As a typical case where the co-operation of the dentist could have proven of great assistance, this author cites the Hillmon case, where years of litigation could have been saved by the use of the teeth for identification. He writes:

> The history of life-insurance litigation demonstrates the value of imperishable physical data for the purpose of identification, and these data the teeth furnish. It is more than probable that much expensive litigation and unfair

decisions would have been avoided if these data had been heretofore utilized. In the celebrated Hillmon case, which dragged its slow length for twenty years through the United States courts of the West, casts of the alleged corpse of Hillmon were placed in evidence which showed that the denture was perfect and regular, while the teeth of Hillmon himself were said to be irregular and some were absent. It was a case in which the body was so disfigured by decomposition that evidence in regard to the teeth was of the utmost importance. If a chart of Hillmon's own teeth could have been produced which showed some of his dental peculiarities (missing teeth, irregularities, fillings, etc.) a comparison with the teeth of the corpse would have been of advantage so that the case would have been sooner settled and much tedious and expensive litigation avoided.

As a very recent case of identification by dentistry, we have the following, which appeared in the *Brooklyn Eagle*, July 22, 1917.

Identification of the body of Miss R —— S ——, 31 years old, of —— East —— —— street, which was picked up on Thursday, when floating off Pier 5, Brooklyn, was obtained yesterday through a description of the bridgework in the girl's mouth. The body had been in the water for nearly eight months.

Detective Wickman of the Bureau of Missing Persons, who was assigned to the case, traced the bridgework to the dentist who made it and through him learned the address of the girl's mother, Mrs. E —— S ——. She positively identified the body yesterday. R —— was a stenographer employed in Wall street, and for some unknown reason jumped off a North River ferryboat, off Twenty-third street, on December 3, last.

CHAPTER VII

IDENTIFICATION OF THE SKULL; RESTORATION OF THE FACE

"Hamlet:	*How long will a man lie i' the earth ere he rot?*
1st Clown:	*Faith . . . . he will last you some eight year, or nine year; a tanner will last you nine year.*
Hamlet:	*Why he more than another?*
1st Clown:	*Why, sir, his hide is so tanned with his trade, that he will keep out water a great while; and your water is a sore decayer of your dead body. Here's a scull now hath lain you i' the earth three-and-twenty years.*
Hamlet:	*Whose was it?*
1st Clown:	*A mad fellow's it was: Whose do you think it was?*
Hamlet:	*Nay, I know not."* —*Hamlet; Act V, Scene I.*

"Der Formenreichthum der skeletirten Gesichtsschädel ist ein so grosser, dass jeder dieser eine bestimmte Physiognomie aufweist; sie sind von einander gerade so verschieden, wie es die Gesichter der Lebenden sind."— M. Holl; Ueber Gesichtsbildung, in Mitt. Anthrop. Gesellschaft in Wien, Bd. XXVII. 1898, p. 57.*

IN 1895, on the occasion of the building of an extensive addition to the Church of St. John in Leipzig, the parish took the occasion to remove the bones of Johann Sebastian Bach, necessarily disturbed by the building operations, and place them in a more fitting resting place, under a suitable monument. Upon excavation they found, as is usual in the crowded churchyards of Europe, a number of skeletons lying one above another, the bones displaced and intermingled with pieces of the wood of the coffins. As the records stated that Bach had been placed in an oaken coffin, remains associated with fragments of fir were rejected, and the two skeletons found in connection with traces of oak carefully collected. Of these two one was the skeleton of a delicate woman, the other that of a moderately robust man. There was little doubt that these latter were the bones of the celebrated musician, but, in order to remove the last trace of doubt the bones were passed over to the anatomist, Wilhelm His,

*(The multiplicity of form in the skeletonized bones of the face is so great that each [skull] displays a definite physiognomy; they are just as different from one another as are the faces of the living.)

of the University there, with instructions to see how well they, especially the skull, corresponded with the extant portraits, busts, and traditional descriptions. Basing his work upon the previous investigation of the supposed skull of Schiller, undertaken some twelve years before by the anthropologist Welcker, His turned his first attention, not to the skull, but to his dissecting-room subjects, to see how deeply the bones of the face

FIGURE 21. Reconstruction of the face of the musician, Johann Sebastian Bach, built directly upon the skull by the sculptor, Seffner, in accordance with measurements made upon the faces of several male bodies by the anatomist, Prof. Wm. His of Leipzig. (*After His.*)

were covered by the soft parts at various points, and if this depth varied very much in different individuals. In this way he studied the bodies of twenty-four male suicides, between the ages of 17 and 72, employing as a means of measuring the thickness of the soft parts a sewing needle set in a handle, and bearing a small rubber disc. The needle was well oiled and pushed through the flesh at the spot selected until it struck the surface of the bone, the disc retaining the measure of the depth after the

withdrawal of the needle. He selected and measured fifteen points in each subject, nine median, along the profile, and six lateral, at essential locations, and found that the variation in the individual subjects was slight. As he had selected suicides he eliminated pathological conditions, and obtained the measures of subjects in normal condition.

His next step was to average up each one of these fifteen measurements, found in each of the twenty-four subjects. He then made a plaster cast of the skull, took it to the sculptor, Seffner, with the points accurately located, handed him his table of thicknesses, deduced from the bodies, and asked him to model a clay face upon the skull, using the exact measures of thickness at each point according to the table. The result was the face of Bach, similar to the best of the portraits.

Striking as was the work of Wilhelm His in this case, a possible criticism lies in the unconscious prejudice on the part of the sculptor, for, although he was not told whose skull it was that he had to work with, and although the plaster cast gave no suggestion of long burial, the affair of the disinterment of the bones of Bach was at that time in the papers, and he must have had some suspicion concerning the identity of the cast handed him by His.

During the next few years this method was applied by various investigators to the skulls of prehistoric peoples; also some progress was made toward ascertaining the thickness of the soft parts of the face in other human races, but no definite and satisfactory test of the method was made. Such a test could be made upon the skull of a known individual, provided the identity was unknown to the man who did the plastic work; it could also be made upon a dissecting-room subject, by first taking a death-mask, then preparing the skull, and handing it over to someone at a distance, who could not possibly have seen either the man or the mask.*

Thus far but one such attempt has been published, and that by Professor Eggeling of the University of Jena, in 1913. He obtained the body of a criminal, executed by hanging, made a plaster of paris death mask, and then turned the head over to the preparator for the purpose of preparing

*At this writing one of the authors has made such a mask and is waiting for a convenient time at which to have the work completed. He has also restored directly upon the skull, the face of a noted scientist, who died some seventeen years before, and the result compares very well with a bust of the same man, made from life by a celebrated sculptor. In performing the work the author purposely avoided seeing either the bust or any picture of the subject, and used a photograph only after the face was complete, and then solely for the purpose of dressing the hair and beard, of the arrangement of which the skull naturally gave no indications. The final result was a decided success, yet the test was not absolute, as the author had known the subject personally, and remembered the face in general, although he would have been quite unable to have reproduced any feature of it directly in clay, without the skull.

FIGURE 22

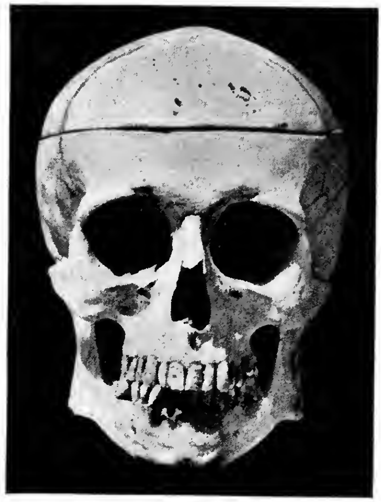


FIGURE 23

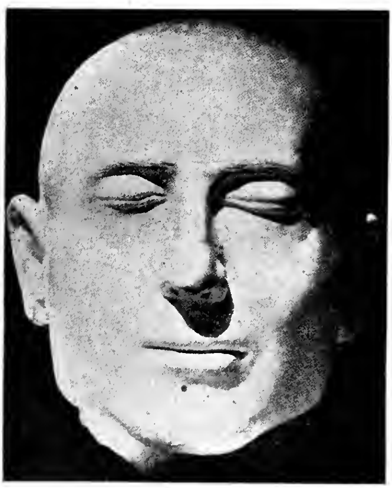


FIGURE 24

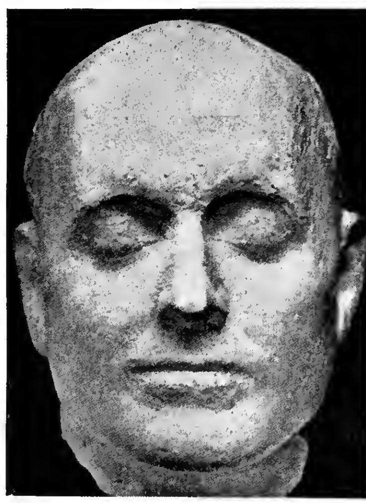


FIGURE 25

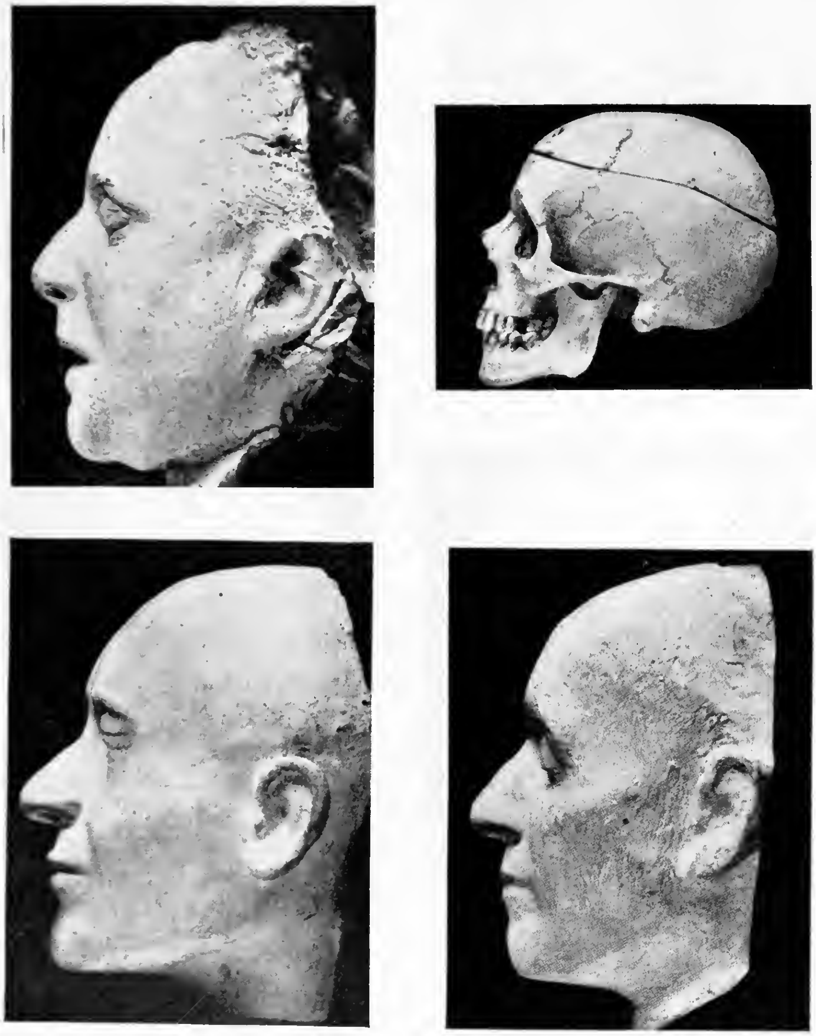
FIGURE 22. Death mask of a criminal, immediately after death by hanging.

FIGURE 23. Skull of the same, and in the same position.

FIGURE 24. Restoration of the face, built upon the skull by the sculptor, Frau Bergemann-Könitzer. She did not follow the measurements exactly, and used her own judgment in several respects, notably the location of the eyes.

FIGURE 25. Restoration of the face, built upon the skull by the sculptor Elster. He followed the measurement given him with fidelity, and produced more satisfactory results than in the other case. In both cases the sculptors were furnished with identical casts of the skull, and were given exact measurements by the anatomist Eggeling, but neither of them was allowed to see either the subject or the death mask. (*After Eggeling.*)

the skull. This he duplicated in plaster, and gave casts to two different sculptors, one the head of the art school in Weimar, the other a woman sculptor in business for herself. The measures for thickness, which he



Figures 26–29. Same as the four previous figures, and arranged in the same order, but showing the profile instead of the full front face. (*After Eggeling.*)

furnished them, were tested in the clay by means of the needle, much as in the case of bodies.

The results of the two sculptors are here presented, together with

the skull and the death mask. The woman sculptor, whose results are manifestly not satisfactory, did not follow the measurements given, but increased the figures for the cheek, the eyebrows, the chin, and some others; she was also not an anatomist, and was ignorant of the relationship between the skull features and the position of the eyeballs, which probably explains the fact that she placed the eyes too high.

The results furnished by the man sculptor were better, and when we take into consideration the open mouth of the real subject, the absence of hair on the reconstruction, and especially the fact that the method is powerless to reproduce the folds, wrinkles, and the other superficial details upon which the individual expression so largely depends, a fair amount of success must be acknowledged.

According to the experience of one of the authors, who has employed this method in reproducing the faces upon several Indian skulls of local origin (Southern New England), the almost universal criticisms offered by the general public are that the data must certainly be lacking for the nose, lips, and ears, and possibly the eyes; in short, that while the shape of the head and forehead, and perhaps also the cheeks and jaws, are indicated by the skull, much of the contour of the parts mentioned must be imaginary. To this we can only say that, in practical experience, much more is given than would seem to one looking over the list of points. The nose, for example, completes fully half its profile upon a bony foundation; the center of its base is also accurately determined by the point in the middle of the upper lip; and its breadth is indicated by the edges of the nasal cavity in the skull, and by the relation between the breadth between them and a certain length measure. In fact, the criticism holds alone in the case of the ears, for which the skull indicates only the position of the opening (meatus), and because of this it is best in a reconstruction to leave the ears somewhat unfinished, and represented by a mass of the usual proportions, with the main features indicated.

The points used for making the measurements, well shown by the accompanying diagrams, taken from Kollmann and Büchly, are given in the following table. There is added also the proper thickness to use at each point for males and females of the white race; also certain averages which have been obtained for Hereros (German Southwest Africa), which, in the absence of more exact data, might well be used for American negroes. The averages for white males rest in all upon 45 individuals, but those for white females are averaged from eight only, the only female subjects thus far measured. The figures for the Herero negroes are taken from three men.

In the negro (Herero) the *italicized* figures will be seen to differ markedly from those for the white race; otherwise the two races show no considerable differences. It is to be hoped that ample statistics for Ameri-

can negroes of as pure blood as possible may soon be furnished by our anthropologists; we should also have fuller data on the faces of Chinese than the results from eight males, furnished by Birkner in 1903-1907.

Location of point	Abbreviation	White males	White females	Hereroes
Occipital, between lambda and inion . . .	o	6.8mm.	?	?
Middle of parietal region	p	5.3	?	?
Forehead; line of hair	St_1	3.56	3.59	3.93
Forehead; middle	f	4.3	?	?
Forehead; glabella	St_2	4.69	4.32	5.36
Nasion	Nw	4.93	4.55	4.76
Middle of internasal suture	Nr	3.25	2.78	3.76
Rhinion; free end of nasal bones	Ns	2.12	2.07	*3.43*
Base of upper lip, at septum	Ow	11.59	9.92	12.16
Prosthion; middle of hollow in upper lip,	lg	9.48	8.18	*13.63*
Transverse furrow of chin, at base of lower lip	K_1	10.05	10.35	10.46
Gnathion; point of chin, directed forward	K_2	10.22	10.06	9.8
Beneath chin, directed upward	K_3	6.08	6.18	5.26
Middle of eyebrow, or superciliary ridge,	oa	5.65	5.32	*6.85*
Middle of lower rim of orbit	ua	4.29	4.45	*5.65*
Middle of malar bone, highest point . . .	wb	6.62	7.73	7.31
Middle of zygomatic arch	jb_1	4.33	5.32	4.46
Base of zygomatic arch, near ear	jb_2	6.74	6.92	*11.03*
Side of mandible, in front of masseter. . .	Uk	8.20	7.13	9.68
Middle of ramus of jaw, through masseter	Ms	17.53	15.91	18.63
Gonion; angle of jaw	Kw	10.46	9.53	*13.61*

In the negro measurements the extra thickness concerns the lips, the surroundings of the eyes, and the point located just in front of the ear; in the Chinese the points about the nasal bones are thicker, that is, the nose is better clothed with flesh than in whites.

For making an actual reconstruction on a skull clay may be used, but a much better material is plastilina (or plasticina, another trade name for the same thing), which does not dry. There are several degrees of hardness of this substance, and a fairly hard quality should be selected, as hard as can be well worked. The first thing to do is to set the jaw in a natural position. A piece of plastilina placed in each glenoid fossa to receive the condyles holds the jaw, and also forms a substitute for the structures of the joint; the setting of the jaw can then be completed by pushing a mass of plastilina upon the back of the row of teeth, remembering that in life the edges of the teeth usually do not quite meet. Some labor may now be saved by filling the space beneath the jaw, and the hollows

under the zygoma, with cotton, held in place by plastilina. The orbits, however, must be left until later.

After determining the exact location of one of the points to use, a covering of plastilina may be put on, guessing at the thickness, and then testing with a needle and disc, as in the first researches with bodies,

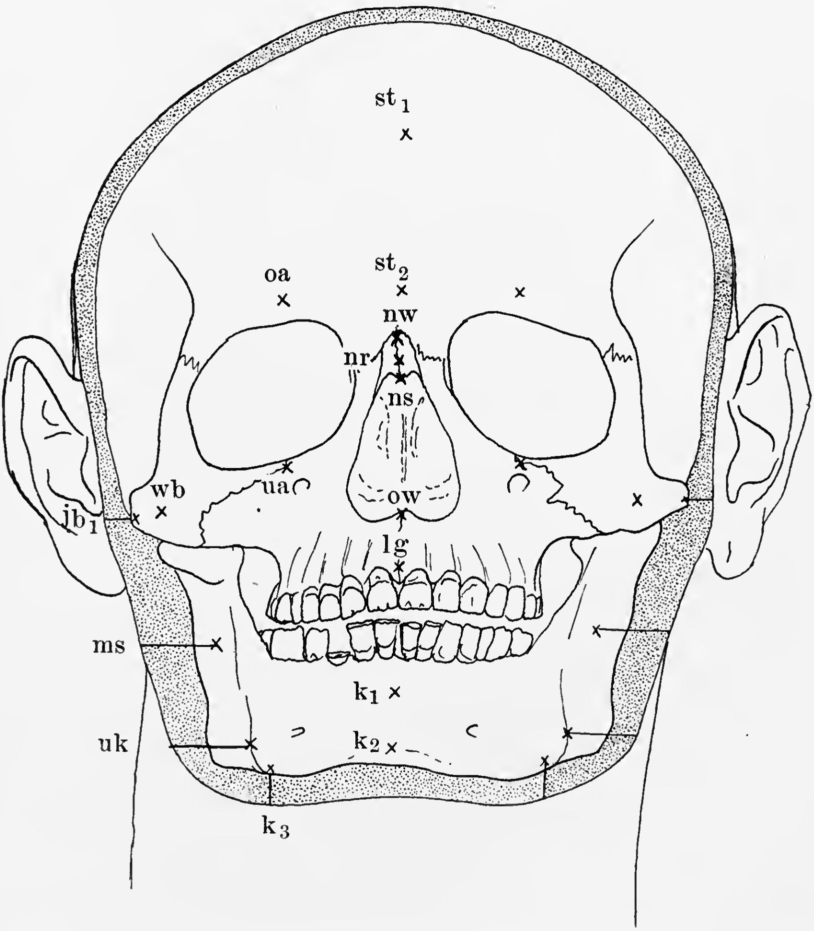


FIGURE 30. Diagram of a human skull, showing the points used in the scientific restoration of a face. Front view. (*After Kollmann and Büchly.*)

or, perhaps better, a narrow strip of paper of the thickness of writing paper may be cut to a length of the exact thickness desired, and imbedded in the plastilina. In actual use the strips are cut about a millimeter wide, and bent across the middle at a right angle. One arm is then measured and cut to the length required; the other serves as a foot, and may be

stuck down upon the bone surface with the plastilina. See that the measured piece projects perpendicularly from the surface of the bone, and then build up on both sides of it with little pellets of plastilina, being careful not to bend it. There is thus formed a cone or pyramid indicating

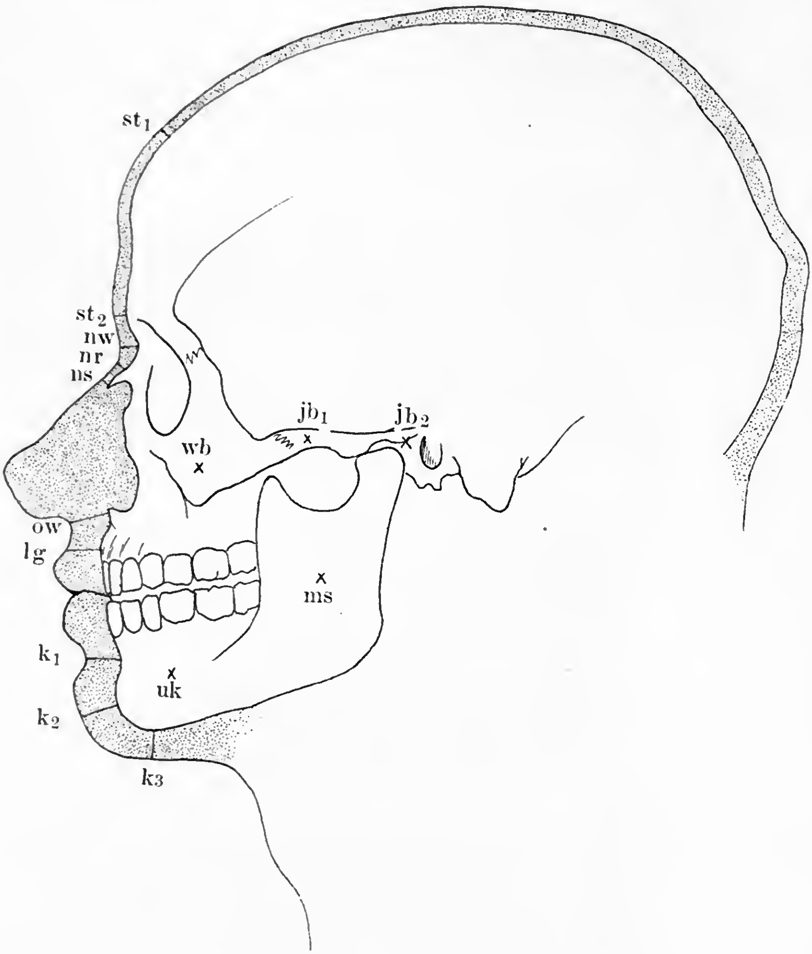


FIGURE 31. Same as the previous figure. Side view. (*After Kollmann and Büchly.*)

the thickness needed at that place, and, after building two or three adjacent pyramids, the space between them may be filled up. It is surprising how obvious are the little white lines on the surface, made by the cut ends of the writing paper, and at any time, if they get covered up, they may be brought to light by gently rubbing the plastilina surface where the strip

should be. At the final finishing of the surface, these can be easily covered up, but it is better to keep them in sight during the progress of the work.*

The construction of the eyes becomes transformed from an unsatisfactory sort of guesswork to a simple and fairly precise piece of work by a method which developed during the course of our own study, and the result will appeal from the underlying anatomical principles upon which it is based. For each orbit we first construct a plastilina eyeball, of the proper size to allow for the eye muscles, glands, and other surrounding structures which in life share the orbit with the eyeball, and fix this immovably on a little bed of cotton, previously packed into the deepest part of the orbit. In the placing of this eyeball there is still some lack of precision in its forward and back location, yet from observations upon living people one may see that in the average eye the edge of a wooden ruler, or other similar object, may be placed vertically over the closed eye and come in firm contact at the same time with the eyebrow, the lower boundary of the orbit and the surface of the lid-covered eyeball. As the eyelid is but a little thinner than the skin covering the other parts named, this means that the plastilina eyeball, set in the skull and tested in the same way should be barely cut by a ruler placed up and down across the orbit and resting on the surface of the bone. Upon this ball, after the surroundings of the eye have been built out, the two eyelids may be fitted, first shaping them to about the correct shape. The two canthi (angles, outer and inner, that form the corners of the eye opening) are located by their relation to certain anatomical landmarks on the skull (naso-lacrimal duct; malar tubercle) and the location kept by means of pins, paper strips, or toothpicks, until the proper time for fitting on the eyelids. This cannot fail to give the general proportions, although the subtle characters which give the individual expression are lost forever.

The nose, although to some extent a fleshy organ, projecting beyond the bone, is nevertheless in its shape and proportions determined far more by the skull than is usually believed. Much of the profile is underlaid by bone, and after building up the points Nw, Nr, Ns and Ow there is practically but one possible way to complete it. The width at the bridge is also given by the bone, and that at the nostrils is indicated by the outer edges of the nasal (piriform) fossa, that conspicuous opening that marks the nose of the skull. These edges about coincide with the outer edges of the nostrils, outside of which (laterally) there comes only the thickness of the nasal wings.

With the mouth the data are at present rather meager, but something can be gathered from a study of the living in respect to the relations between the parts of the lips and mouth and the teeth. Ask your friends

*Poynter uses strips of thin metal instead of paper, and finds them easier to work with and more accurate.

(*Reprinted from American Anthropologist with permission.*)

FIGURE 32. Restorations of faces upon the skulls of four Indian aborigines of Massachusetts and Rhode Island. The first is a young woman; the others are men. Allowance must be made for the omission of the hair, and the lack of the neck and throat.

FIGURE 33. Restoration of faces upon various skulls The first two on the left are negroes; the others are white females.

how they hold their teeth when the mouth and face are quiet, whether the edges are in contact or not, and you will probably find that in most cases the teeth are held open a little, a point which will help in the setting of the jaw, the first step in a reconstruction. Again, when the mouth is in repose, and held quite naturally, without a smile, place toothpicks straight in at the corners, until they strike a tooth; then ascertain which tooth this is, and the exact point at which it was struck. This seems to be usually at about the middle of the second upper bicuspid, but our experience has been very limited in respect to this important point, and there may be some individual difference. When this point is determined, toothpicks may be fastened to the skull under construction, and as they project through the plastilina, they are ready to mark the exact limits of the mouth slit when the modeler is ready for it.

The size and fulness of the lips, although not given directly, are well indicated by fixing the median points above and below them, lg and Kl. The first of these, upon the edge of the alveolar ridge in the skull, marks the center of the little median hollow in the upper lip of the living; the second corresponds to the place where in the inside of the mouth the lower lip becomes attached to the underlying bone. These points, together with the slope of the alveoli and teeth, and the exact position of the mouth slit, hedge the problem around with so many known conditions that there is but slight opportunity for the manipulator to vary his work, or to construct more than one type of mouth upon a given skull.

For the external ear there are no data other than that of its position, given by the external opening. It must here be remembered that this does not coincide with the visible opening in the living, but the latter lies a little below and in front of the opening in the bone. There is here a little individual variation, but as an average 5mm. may be allowed each way; that is, the plastilina ear should be so placed that the center of its external opening lies 5mm. in front of, and also 5mm. below, that of the bony opening.

Probably a more detailed study of the correspondence between skull and soft parts in the facial region, taken in a large number of bodies, will add much to our ability to build up the features correctly on the bony face. There are undoubtedly many more correlations between the soft features and the underlying hard parts than we know about at present, since in a region where the two are so intimately related as on the face any change in the former must bring about some change in the latter. The droop of a lip, or the increased weight of an eyelid, may bring with them some slight change in the bone beneath, and these correlations between the soft and the hard parts we may sometime learn to read.

In two points only, that of the bodily condition of the subject, whether well nourished or emaciated, and that of the presence and location of

wrinkles, two closely associated superficial characters that differ at times in the same individual, can the skull not be expected to furnish much

FIGURE 34. Restoration of the face on the skull of a female cliff-dweller, a member of a prehistoric race of southern Utah. This is the same woman shown in Figures 15 and 16, but the restoration has been effected by quite different means. In Figure 16 the original flesh was soaked up to presumably its normal shape and size by caustic potash; in this case the previous specimen was skeletonized and the face restored by the addition of plastilina to the surface of the cleaned bones.

information; and inasmuch as these details, superficial as they are, are much relied upon in sight recognition of individual faces, the method, to the unscientific, will always have its deficiencies. Even here, however,

certain of the deeper folds and wrinkles can be inferred from the general relations of the bony surfaces, and assuredly many of the traces of senility, the shrunken gums, the flattened curve of the jaw, and the approach of nose and chin, are as strongly marked in the skull as in the face.

When perfected there is practically no end to the applications of this method of face reconstruction, especially in its medico-legal aspect, that is, in identification. Of the 278 skeletons obtained from the wreck of the *Maine*, raised from the harbor of Havana, only a few could be identified, and these only by the aid of the associated objects, such as swords and buttons. Had the skulls been reconstructed by this method it is probable that with the co-operation of relatives and friends but very few would have remained unidentified.

While these scientific methods of restoring the face upon the skull, based on careful measurements, have been employed chiefly as tests, and, with the exception of the case of Bach, have not been applied directly to identification, in September, 1916, a similar means was resorted to by the New York Police in establishing the identity of a probable murder victim, and thus the La Rosa case becomes the first in which identification by a facial restoration plays a part. Not wishing to trust to the somewhat highly colored "stories" from the daily press concerning this case, the authors obtained an account of the process both from the son of the artist and from the Police Department, and are thus enabled to present an authentic account of this notable case.

We may first quote from a personal letter from Mr. G. H. Scull, Fifth Deputy Commissioner of the Police Department of the City of New York, whose courtesy in furnishing these particulars we take pleasure in acknowledging. Commissioner Scull writes:

"At 6 P. M., September 12, 1916, workmen engaged in excavating for the cellar of an apartment house at Hegeman Avenue and Powell Street unearthed a human skeleton. The skeleton was a man apparently 25 years of age, 5′, 6″, dark brown hair, two gold teeth in lower jaw, blue coat and trousers, black leather belt and a briarwood pipe. The wisdom teeth were just protruding from the jawbone, a portion of dark brown hair was attached to the base of the skull and a small quantity of hair was attached to the top of the head and it looked as if the man was inclined to be bald. Four fractures appeared,— three at the base of the skull and one large one at the top of the head.

"At 9.30 A. M., September 27, Lieutenant Williams, together with Dr. Pacini of the Standard Testing Laboratory, and Dr. Pacini's father, who had some experience in this line of work, started to rebuild the face on this skeleton. The father of Dr. Pacini bought some clay known as 'Plasteline,' and with this they built up the face. Some clippings from hair cut in a barber shop were secured, several pairs of glass eyes were

requisitioned from a nearby glass eye factory. It was then necessary to have a neck. Lieutenant Williams took a coffee can and the necktie found on the skeleton just fitted the can. A roll of newspaper served as a spinal column, which was cut to the depth of the can and made rigid by soft paper and clay. Lieutenant Williams figured that an Italian with dark brown hair would naturally have brown eyes, and a pair of brown eyes that were best suited to the sockets were selected out of the stock. The eyebrows were trimmed, and a small quantity of hair was placed over the right ear, and continued down the neck to meet the natural hair at the base of the skull. Photographs of the results were then taken.

"For several days the locality where the skeleton was found was canvassed and several persons said they were sure the man was on the farm where his body was dug up, but we were unable to secure his name. A few days later a second skeleton was found near the same locality and the cuts on the skull showed a similarity to those on the first one. When the remains of this second skeleton were searched by detectives from the Seventh Branch, a check was found payable to the order of Rosario Passorello, dated November 17, 1914. The missing persons records were searched and it was found that he had been reported by his sister, who was located, and the remains identified by means of clothing and articles found in same. On September 24, friends of Passorello gathered at the Seventh Branch for the purpose of identifying his effects, and a man named J—— R—— was arrested charged with the crime.

"Lieutenant Williams took the photographs and head to the Seventh Branch, and while M—— O—— and V—— P——, relatives of Passorello, were looking at the photographs, Lieutenant Williams uncovered the head and P—— pointed to it and exclaimed, 'That's Dominick, Dominick La Rosa!' O—— exclaimed, 'That's Dominick's necktie, only more red.' P—— then lifted the hat and said, 'Dominick a little bald, and had two gold teeth' and he tried to push the lips open to see the gold teeth.

"On October 8, at the Grand Jury rooms, one J—— S——, who had known La Rosa for several years, and saw him a day or two before he disappeared, stated that the head looked like La Rosa, but his cheeks were a little fuller. When Lieutenant Williams took some of the clay from the back of the neck and filled in the cheeks, he declared that it looked just like Dominick La Rosa."

Thus an identification of a skeleton, without flesh, was made from a restoration, while the only clue obtainable was the proximity in the earth to a second skeleton, identified by a bank check. Much credit should be given, both to Lieutenant Williams, who first conceived the idea of a restoration, and to the two Pacinis, father and son, who brought the matter to completion.

PART II

Methods Which Furnish Absolute Identification

CHAPTER I

FRICTION-RIDGE CONFIGURATION; TECHNIQUE OF MAKING AND STUDYING PRINTS

"*If they (the ridges) had been only twice as large as they are, they would have attracted general attention and been commented on from the earliest times. Had Dean Swift known and thought of them, when writing about the Brobdingnags, whom he constructs on a scale twelve times as great as our own, he would certainly have made Gulliver express horror at the ribbed fingers of the giants who handled him. The ridges on their palms would have been as broad as the thongs of our coach-whips.*

"*Let no one despise the ridges on account of their smallness, for they are in some respects the most important of all anthropological data.*" — *Sir Francis Galton; Finger-Prints, 1892, pp. 1-2.*

THE skin covering the lower surfaces of the hands and feet, including the palms, the soles, and the balls of fingers and toes, differs markedly from that of the general body surface. It is entirely without hair, which, in rudimentary condition at least, covers the rest of the body; it is without the pigment or coloring matter which, even in a white person, is present elsewhere in some quantity; and, what is important for us, *it is covered with minute ridges, in some places running in parallel course, like a piece of corduroy, and in others forming various kinds of loops, spirals, or whorls, known as "patterns."* In many of the lower mammals, especially the monkeys, these ridges are much coarser and heavier than in man, and perform the important function of preventing the surfaces from slipping, or "skidding," during the rapid movements involved in a life in the trees. They are hence called "*friction ridges,*" and the skin areas thus marked are called "*friction skin.*"

As the separate ridges are frequently interrupted, or form a fork by fusing with an adjacent one, even the more monotonous areas where the ridges run in parallel course are not without individuality, so that while no two areas of appreciable size can ever be the exact duplicates of each other, it is where the ridges become involved in the formation of a "pattern" that their individuality becomes the most readily apparent. It has been shown above that a single pattern, that of the right thumb, for instance, of three men with similar faces, is sufficient to distinguish each absolutely, however much they may resemble one another in general appearance (Figure 4). On the other hand, the identity of a man may be

maintained by a finger print, or any other portion of the friction skin, no matter how great a change may be effected in his face and general appearance (Figure 10).

To begin the actual study of friction skin nothing more is at first necessary than your own hand. Hold it in a good light and look over the palmar surface. If a reading glass is handy it may assist, but for normal vision it is not necessary.* At first you will perhaps see nothing but the *wrinkles*, those folds and creases of skin developed through the continual movements of the hand and fingers, and so advantageously used by palmists, though without the slightest scientific basis, in turning credulity into capital.

Now focus your attention to some rather prominent part of the palm, for example, the large pad or cushion which runs along the outer edge of the palm, or the transverse cushion at the base of the fingers, and you will see that the entire skin surface is made up of *friction ridges*, perhaps running straight and parallel, perhaps forming here and there a *loop* or other form of *pattern*. These ridges, when once identified, may be followed over the entire surface of the palm and the palmar surface of the fingers, but in hollows and flat places, as in the center of the palm, they are often flat and indistinct. On the *balls of the fingers* (the fleshy pad covering the end joint) they are always distinct and strong, and in most cases form a complicated pattern, usually a *loop* or a *whorl* (little concentric circles), the center of the pattern coinciding with the raised middle point of the pad.

After the ridges of one hand have been studied, and the general location and form of the patterns learned, take the other hand and note the differences. These may possibly not be very noticeable, but it is altogether likely that at least one striking difference will be noted. Finally, study the ridge conformation on the hands of a few other persons and compare them all. The amount of difference you find will be about proportionate to the carefulness of your observation, although if the entire investigation be limited to but three or four persons, especially if they are members of the same family, you may chance not to get any marked or striking differences.

The second lesson should consist of learning how to make a print. You need for this a little printer's ink, a small rubber roller, a glass plate,

*In addition to a reading glass it may be found convenient to employ a magnifying (concave) mirror, such as are sold for shaving mirrors. These are not only stronger than ordinary reading glasses, but are especially convenient in places which are hard to get at directly. Thus, in examining the foot, where the use of this device would save an awkward position on the part of examiner, subject, or both. Here, if the ridge crests are inked slightly with the roller, or are merely soiled by the pick-up dust from the floor, the contrast between them and the clean furrows brings out the pattern with almost the clearness of a print. G. T. M.

and some smooth white paper. Glazed paper is the best of all. The best ink to use is that used for the mimeograph or neostyle. It comes in tubes of various sizes. For a roller the regular mimeograph kind is the best, but the hard rubber rollers used in amateur photography give fair results. The glass plate should be large enough to receive an entire hand or foot, perhaps 6 x 10 inches. For hands the paper should be cut 14 x 10 inches, and for feet 14 x 12, or the latter size may be used for both. One such piece will hold the pair, placed in the natural order, the right on the right side.

Put a little ink upon the glass plate, spread it into a thin layer with the roller, press the ball of a finger or thumb upon this, and then several times in succession along a small strip of paper. This will show how much ink to use to get the best results, since in your experiment the first print will probably be too black, and the last will certainly be too faint. Even with about the right ink surface a second print, taken without reinking, is very often better than the first.*

When this simple technique is learned, prepare an inked surface large enough to receive the entire hand, with the fingers extended naturally, and print in the same way, first laying the hand, with a gentle pressure, upon the inked surface, and then upon a sheet of paper. In most hands the center of the palm does not naturally come in contact with a flat surface when the hand is laid against it, and this may be remedied by pressing down upon the middle of the hand, both upon the ink and upon the paper. One inking will usually make two prints, but each time the inked surface is used it must be first rubbed smooth to obliterate the impression of the previous use.

In such a print of the hand the entire configuration of the palm, or practically all of it, will be shown, but the patterns upon the ends of the fingers run over the sides, that is, they are drawn upon the surface of a cylinder, and thus the print shows only the middle part of these. With the thumb, as it is set obliquely, the matter is still worse, and only the outer side of the pattern appears. To print the whole of one of these patterns, then, it is necessary to roll the finger from one side to the other, first upon the inked surface, and then upon the paper; and thus to make the hand prints complete rolled prints of the finger patterns should be added along the margin of the sheet, in association with the hands to

*In large police departments the identification office is equipped with special furniture for taking prints; a table with a glass top, rollers made for the purpose of composition material, and so on. Where footprints are also to be taken, the furniture should include a table with a raised seat at one end, upon which the subject should be seated, as on a boot-black's "throne," to which convenient access should be had by means of steps. These and similar devices will naturally develop through the ingenuity of the individual workers, but all that is essential, after all, are the ink, the roller, the paper, and the smooth plate, as here described.

which they belong, and in the natural order. The *dab* or *plain* impressions, as they are called, obtained while printing the whole hand, are of the greatest value in giving the absolutely correct order, and serve to correct any error in the arrangement of the separate finger prints.

Prints of the feet are taken in much the same way as is the hand, save that the subject stands or sits, and the plate and paper are spread out on the floor. A heavy subject, when standing, is apt to press too hard and tends to flatten the ridges so much as to obliterate the interspaces in places, and on the whole the sitting position is the best for all subjects, as the foot may then be placed and otherwise manipulated by the one taking the print.* Some pressure at the base of the toes, as recommended for the center of the palm, is advisable, as it extends a little the portion that prints, and often reveals important details. The separate toes cannot easily be rolled, and, although they present excellent patterns, so that a single toe pattern would suffice for a perfect identification, a case where the identification would depend upon it would very seldom come up and thus for practical considerations the toe patterns may be neglected. On the other hand, the outer edge of the foot, a little beyond the *tread area* (the part used in an ordinary step), often shows important features, and these can be brought within the limits of the print by rolling the entire foot, beginning on the outer edge, or this edge can be printed separately.

As printing ink consists of lamp-black ground up in oil or vaseline, it does not stain the skin like ordinary writing fluid, and may be easily removed by any solvent for oil, such as turpentine or gasoline. A cloth moistened with one of these will clean the flesh quickly, and ordinary soap and water, with some little scrubbing, will remove most of it. A dry cloth to wipe the surface immediately after it is printed will save the clothing and surrounding objects.

If, now, a print be compared with the original surface, it will be seen that, while the one is an exact duplicate of the other, even to the finest details, the print possesses the following marked advantages as an object for study and comparison:

1. In a print the ridges are shown as black lines traced upon a white background, while on the skin surface both ridges and interspaces have the same color.

*Where much printing is to be done it is advisable to install a permanent stand for the work. This requires nothing more than a good wooden table, about two and a half by four feet, and fitted with a seat across one end, perhaps 14 inches high. For the hand printing the free part of the table is sufficient while subject and operator stand beside it; for the feet the subject sits on the box, with the feet on the table. The table should be high enough for the operator to work comfortably standing beside it, and for the convenience of the subject, steps should be arranged for mounting the table. Needless to say, this latter should be very strong, and should not even shake under the weight of a heavy subject.

2. A print shows the pattern spread out over a perfectly flat field, while in the real object the surface presents a more or less marked relief. In a finger the pattern is depicted over the surface of a cylinder, which it is necessary to turn in order to see the whole.

3. The wrinkles are a more disturbing element on the actual skin than in a print, for in the first they are often deep grooves, while the very means employed in taking the print tend to flatten them out. Thus in a print the smaller wrinkles are often quite lost, while even the deepest ones appear only as irregular breaks that do not print, over which the ridges may be easily matched.

4. There are numerous mechanical difficulties in studying the real hands; while with the feet the difficulties are still greater. A print is spread out upon a table, where it is in the most convenient position for observation.

5. To study the actual hands the subject must naturally be present. With a collection of prints one has the records of any number of individuals, any and all of which are instantly available, not only for separate study, but for comparison.

6. A print, or any part of one, may be conveniently photographed, either at the natural size or at any required degree of enlargement. It may in this way be duplicated indefinitely and sent to any part of the world. With an enlargement of only a few diameters such a photograph may be used before a jury; an especially good form of use is that of projection with a stereopticon. The actual skin is not fitted for any of these uses.

CHAPTER II

STRUCTURE AND DEVELOPMENT OF FRICTION RIDGES; DETAILS OF THEIR COURSE AND ARRANGEMENT

"*Mira vallecularum tangentium in interna parte manus pedisque, praesertim in digitorum extremis phalangibus dispositio flexuraeque attentionem jam nostram in se trahit.*"* — *Purkenje; Commentatio de Examine Physiologico, etc.; 1823.*

If a small area of friction skin be observed under a lens having a magnifying power of five or six diameters, or with a strong reading glass, there will be seen running along each ridge a row of minute depressions, at about equal distances apart. These are the *sweat pores*, or mouths of the sweat glands. The ridges, too, are not generally continuous across the entire palm, but are broken into sections of varying length, the shorter ones having but two or three sweat pores, and some but a single one. In this latter case, technically called an *island*, the shape of the ridge is circular or oval, and the sweat pore is in or near the center; and in ridges of two or three sweat pores the appearance often suggests, by its indented border, a fusion of as many separate islands, each with its own pore. Along the transition region between the friction skin and the usual type this appearance is frequent, and the ridges are seen to begin as separate islands, placed in a row, gradually melting into one another until the typical ridge formation is attained. An especially convenient point to observe this is along the outer edge of the second joint of the left index finger.

Thus (1) from the existence of the sweat pores along the ridges at approximately equal intervals, (2) from the presence of very short ridges, the so-called "islands," containing a single sweat pore; and of others, plainly made up of two or three islands, and showing a sweat pore for each unit, and (3) from the appearance of the ridges at their beginnings on the transition area, where they are clearly seen to consist of rows of islands in all degrees of fusion, and where all stages are seen, from distinct islands to a completely formed ridge, it becomes evident *that the friction*

*"We now turn our attention to the remarkable disposition and windings of the tangential furrows on the inner side of hand and foot, and especially upon the distal phalanges of the digits." [Free translation of the above. The original stands: "The remarkable disposition . . . . now draws our attention to itself," etc. Galton seems quite right in questioning the meaning of the word "tangentium" here.]

ridges are formed by the fusion in rows of minute round or oval structures, each having a single sweat pore in its center, so that the sweat pores occurring along a ridge indicate the number of separate unit islands of which it is composed.

This explanation of the composition of the ridges is confirmed by a comparison with the condition found in other animals. While in monkeys the palmer and plantar surfaces are covered with friction ridges as in man, but larger and heavier, there are many lower mammals in which these areas are still covered with the separate units; there are also some in which the ridges are found in the act of forming, and cover the most prominent surfaces only, while the hollows show separate units, often not definitely arranged. Again, in some there are found no actual ridges, that is, no fusion between separate units, but over the raised pads of the palms and fingers the units are arranged in whorls, loops, and the other patterns characteristic of the ridges covering these places in the higher forms.

Going back again to the most primitive case, where the surface is covered with separate unit islands, without definite arrangement, there is much to suggest that the units themselves are modifications of the scales with which the bodies of typical reptiles are clothed, and which the earliest mammals still retained. At a later time the scales were lost over the rest of the body, but were retained in this modified form over the palmar and plantar surfaces, where they were eventually transformed into friction ridges.

The general arrangement of these ridges, the varying direction of their course over different areas, and especially the patterns, with their endless varieties, although they may seem at first to be entirely the result of chance, correspond, nevertheless, to a fundamental plan, which, like so many other problems of human structure, finds its explanation in Comparative Anatomy.

To begin with, the more primitive walking mammals, designed for life on the ground, and in burrows and clefts in the rocks, developed on the contact surface of each foot eleven raised pads or cushions, to bear the weight of the body and furnish the necessary elasticity; and in their modern representatives, like the squirrels, the mice, and the shrew-moles, this condition is retained and may be easily studied. These eleven pads run across the paw in three transverse rows, (1) a proximal row near the wrist, (2) a middle row at the base of the digits, and (3) a terminal, or distal, row on the end joints of the digits. The proximal row consists of two pads, the *thenar*, on the inner or thumb side, and the *hypothenar*, on the outer or little finger side. The four pads of the middle row are placed just beneath the four intervals between the digits, and are conveniently called the *interdigitals* (between the digits), and are numbered

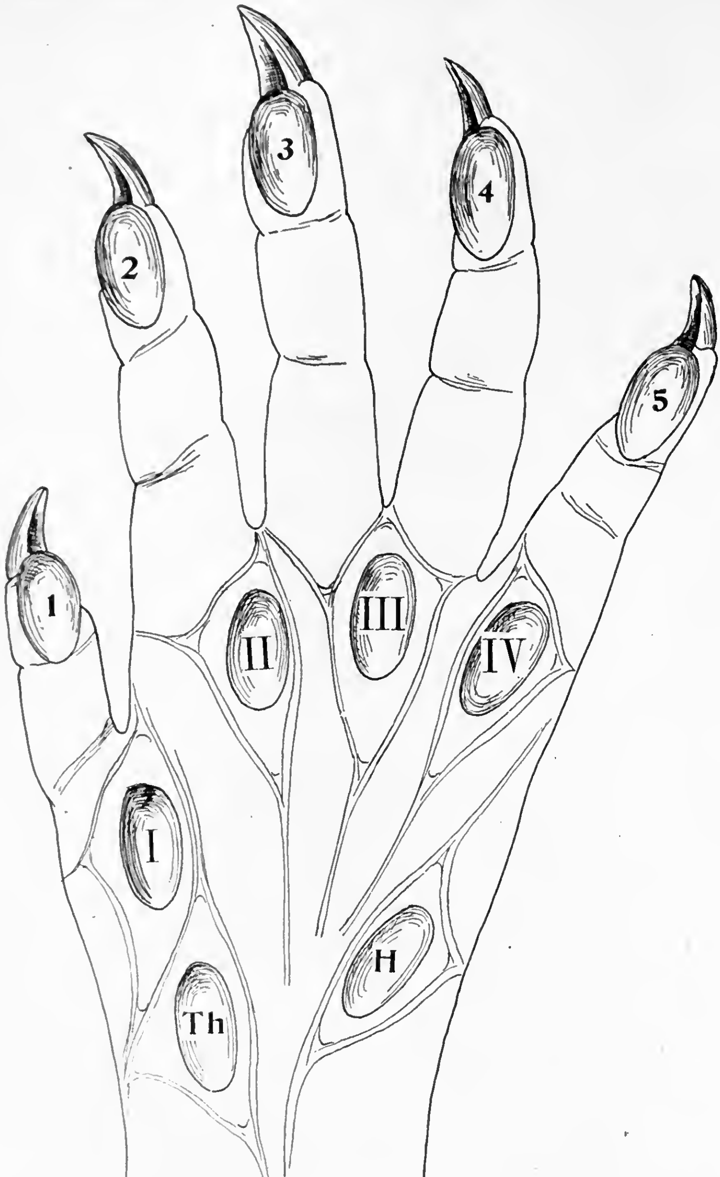


FIGURE 35. Diagram showing palmar surface of fore-foot and digits in *Microtus*, a field mouse. The pads are rounded eminences, surrounded by folds as indicated. The triangular areas are the points where the folds come together, forming deltas. The entire surface, including pads and folds, is covered by separate epidermic units, not yet united in rows to form ridges These are not shown here. (From the Biological Bulletin, by permission.)

from I — IV, beginning on the inner side. The pads on the ends of the digits are naturally five in number, and are termed *digital* or *apical* (1 — 5).

These eleven pads are found to be surrounded by folds of skin, two, three or four about each pad, and so arranged as to form a slight depression or pocket for the reception of the pad. At the points of contact of each two of the folds, they are prolonged to form a third edge, running away from the triangular pocket, so that the whole structure, composed of the two edges which help to enclose the pad, and the third edge, the prolongation away from the pad, makes a three-pointed star, called a *triradius*. The region where these three folds meet, is a *delta*.*

This arrangement is seen in its most typical form in connection with the pads on the palm or sole, where in all cases but one, the folds, and consequently the deltas, are three in number; but in the case of the third interdigital, placed beneath the interval between the third and fourth digits, there are four folds and four deltas.

The apical pads are peculiar in having but two deltas, while the folds coming up from them and running toward the end of the digit unite to form a large loop, enclosing the pad.

All these surfaces, the pads, the folds, and the spaces between them, are covered by epidermic units, each with a sweat pore, and where they come into constant contact with external objects, as on the surfaces of the pads, they show the usual tendency to arrange themselves in rows and fuse into ridges. In mammals that walk on the ground the ridges on the pads run transversely across them, that is, in the direction best suited to cause friction and prevent slipping; but in certain animals that live in the trees, and are in structure part way between these terrestrial forms and the arboreal monkeys, the ridges upon the pads form themselves into concentric circles or ovals, the center coinciding with the middle of the pad, where it is the most elevated. *This is the first appearance of true patterns, and it is interesting to note that they are in the form of whorls, and that they occur on all of the eleven pads.*

The next step is shown in those monkeys which are wholly arboreal. Here the pads are reduced in height, so that the palms and soles are nearly flat, and all parts of them come into contact with the tree boughs and other external objects. *Thus the entire surface becomes covered with ridges, but, instead of running straight across, the newly added ridges retain the direction of the folds that originally surrounded the pads.* Thus we now have,

*The term *delta*, which suggests a triangle, was introduced by Galton, and evidently includes merely the small area where the three folds meet. The term *triradius* introduced by one of the authors, and now extensively used in anthropology, suggests a three-pointed star, and includes both the delta and its three radiating lines. In fingerprint technique it is necessary to use a definite point, the meeting place of the three ridges in the center of the delta, and this point is spoken of as the *point of delta*.

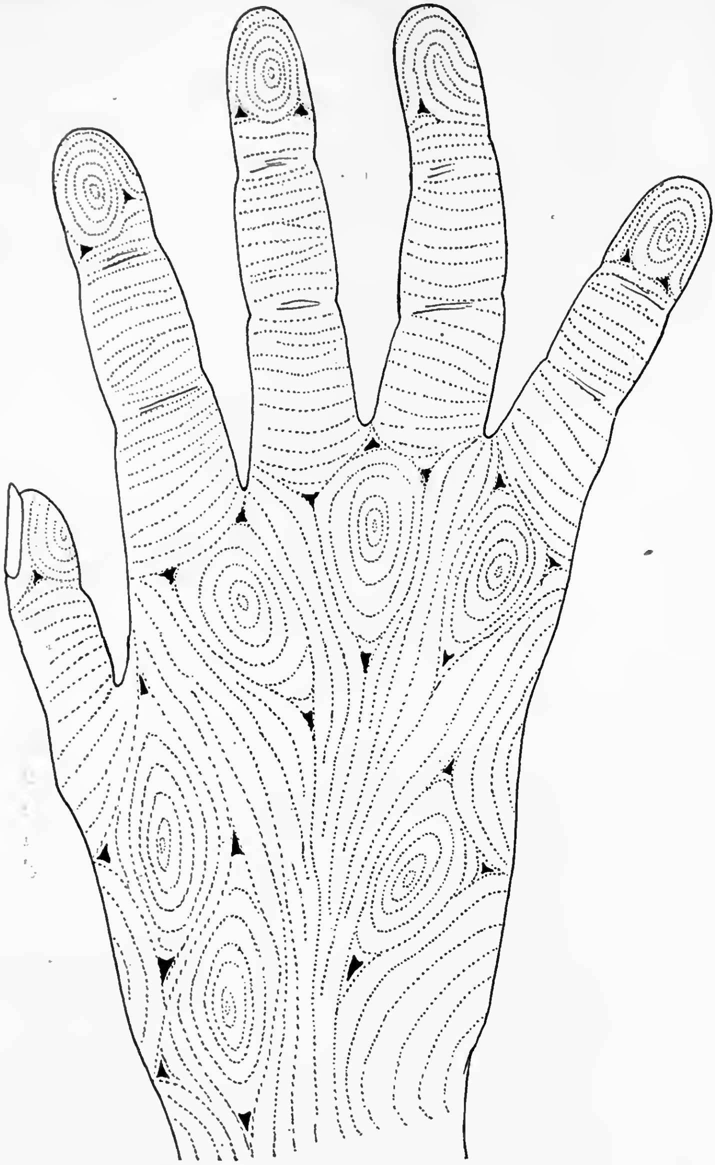


FIGURE 36. Diagram showing condition of palmar surface of hand and digits in *Macacus*, an East Indian monkey. The surface is flattened, but the moulding of the ancestral relief is indicated by the arrangement of the ridges, which cover the entire surface. In the fourth digit the pattern is represented in the first stage of degeneracy, which is brought about by the loss of one of the deltas, converting the primitive whorl into a loop. This is sometimes found in the apical patterns of monkeys, and is given here in one of the digits to show the tendency. (From the Biological Bulletin, by permission.)

upon the flattened palmar and plantar surfaces, not a chance arrangement of ridges running in all directions, but *a picture or drawing of the paw surface*

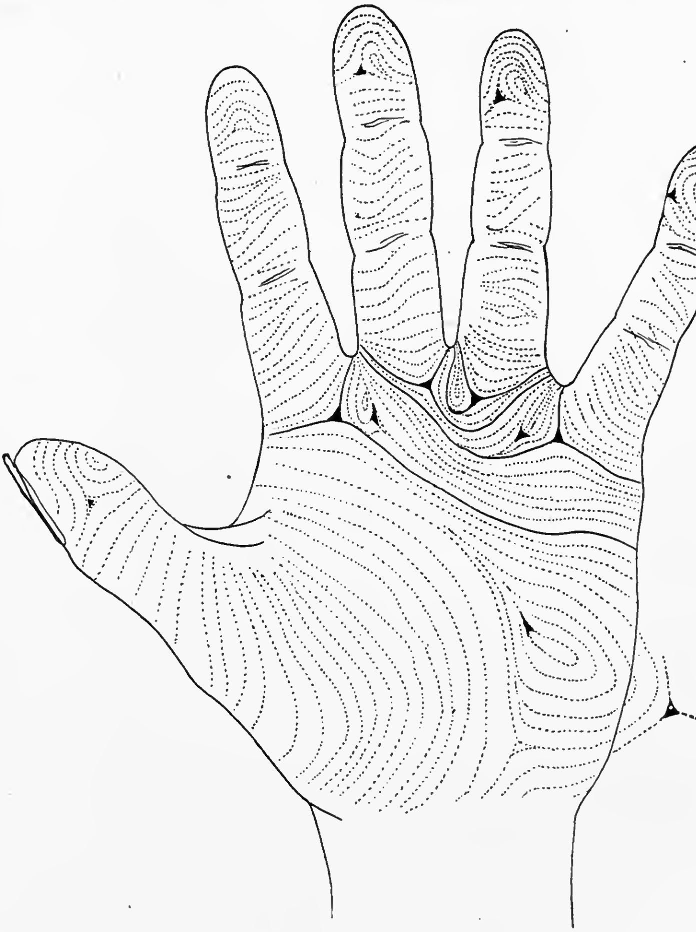


FIGURE 37. Diagram taken directly from the print of the right palm of a young white woman (English and French ancestry, H. H. W. Coll., No. 90), showing rather more than the average number of the original patterns. The two on the thumb side of the palm are absent, although they appear in others figured in this chapter. Aside from these, however, the remaining patterns, as seen in the paw of the monkey, or as represented by pads in the paw of the field mouse, can be readily located. In the great majority of human hands the loss of the original characters has proceeded much farther, and the palm is more or less free from definite patterns. (From the Biological Bulletin, by permission.)

found in their terrestrial ancestors, with every detail of the pads and their surrounding folds. The pads are indicated by the patterns; the folds by lines and systems of ridges running at each point in the old direction, with the

triradii and deltas as before. The flattening has simply removed the third dimension, and the *relief* has become a *drawing.*

As has already been shown, these ridged friction-skin surfaces are of great functional importance to the smaller monkeys, where the ridges are large in proportion to the size of the animal and where their life continually depends upon the certainty of their grasp. When, however, as has happened in the great apes, and in man, the body weight has become so considerable that skin ridges are of little value in grasping, their particular arrangement becomes of no account, and is allowed to degenerate. The patterns placed upon the raised cushions, and still of much value, in their whorled arrangement, in a little tree animal weighing ten or twenty pounds are no longer any better than ridges running straight across the palm, and are found in all stages of degeneracy or, more frequently, are entirely gone. Occasionally, however, a human palm may be found in which all of the eleven patterns are present, each in its proper position, and the five apical patterns, which still have some little use in handling small objects, are almost always present. Certain of the folds, too, with their associated deltas, are nearly, or quite, constant, and are made use of in this book as the basis for the classification used.

This sketch of the evolutionary history of the palmar and plantar surfaces is necessarily a brief one, but the reader is referred to the technical papers which, during the past dozen years, have elucidated this hitherto neglected subject, and put the history of the friction skin and its ridges on a plane with other departments of comparative anatomy. To those who prefer a rational explanation for such phenomena, and do not like to refer it all to chance, this explanation of the origin of the features found in the friction ridges may prove of interest.*

* Something of the vast array of facts connected with this subject are brought out in the writings of Miss Inez Whipple (Mrs. H. H. Wilder), Otto Schlaginhaufen and W. Kidd. The last-named author has also contributed largely to the study of hair direction on the bodies of man and other mammals, a matter which occasionally has some bearing on identity. De Meijere has found proof of the former coat of scales possessed by mammals through the study of the arrangement of the hair in the skin of mammals. For the benefit of those who wish to continue this subject further, the following books and papers are recommended:

Whipple, Inez L., 1904. The Ventral Surface of the Mammalian Chiridium, with especial reference to the Condition found in Man. Published in the Zeitschrift für Morphologie und Anthropologie, Bd. VII, pp. 261-368, 54 text-figures and two plates.

Schlaginhaufen, O., 1905. Das Hautleistensystem der Primatenplanta, mit Berücksichtigung der Palma. Morphol. Jahrbuch, Bd. XXXIII, pp. 577-671, and Bd. XXXIV, pp. 1-125. 194 text-figures.

Kidd, Walter, 1907. The Sense of Touch in Mammals and Birds, with special reference to the Papillary Ridges. Published by A. and C. Black, London. 176 pp., 174 text-figures.

Owing to the composite structure of the friction ridges, and the tendency of the units to combine in various ways, or to remain separated in places, a patch of friction skin, even where there is no pattern, is by no means a monotonous succession of parallel lines, but encounters variations at every point which render such a patch as individual and incapable of being duplicated as is a part which, by some unusual and conspicuous curve or loop, would much more readily arrest the attention. We have already referred to the frequent occurrence of breaks in a ridge, places where the original units do not fuse; there are also cases where units belonging to two

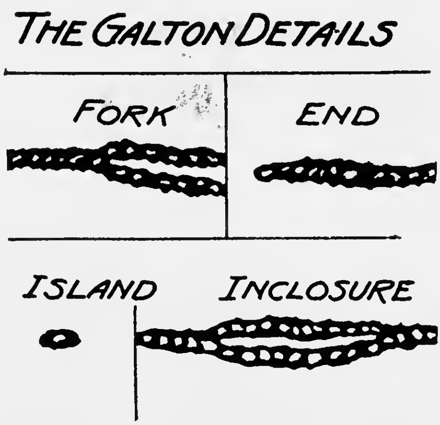


FIGURE 38. The "Galton details"; these, which Galton first called *minutiæ*, are the most common departures from a straight, continuous, and parallel course, that occur in friction ridges. The presence and location of these and similar peculiarities may be resorted to when comparing single patterns that are otherwise very similar, or when studying the characters of a small area of friction skin anywhere. (See Figures 39–41 following.)

adjacent ridges fuse across the interspace, forming a fork. These variations, first described by Sir Francis Galton under the term *minutiæ*, have now become known as the *Galton details*, and are often, in cases where there is a comparison between two similar patterns, or in cases concerning a little patch of friction skin without a definite pattern, of the first importance in identification.

Kidd, Walter, 1903. The Direction of Hair in Animals and Man. Published by A. and C. Black, London. 154 pp., 33 text-figures.

De Meijere, J. C. H., 1894. Ueber die Haare der Säugethiere, besonders über ihre Anordnung. Morph. Jahrbuch, Bd. XXI, pp. 312-424. 41 text-figures.

A complete bibliography of this extremely large field would be quite impossible here, but much of it is given in the references contained in the works here cited. The papers given here, especially those by Miss Whipple and Kidd, are recommended to those who wish to learn the underlying conditions for the formation of the friction ridges and the patterns as they occur in man.

The most frequent of these is probably the *end*, where a ridge simply stops, allowing those on its two sides to close up. A *fork* is where one ridge becomes two, which continue in contact with each other. When a fork exists for a short course, perhaps the length of a dozen units or so, at the end of which the two ridges melt into one again, there is formed an *inclosure*. Short ridges, composed of a few units, are of common occurrence, and when these are so short as to contain but a single unit or so the ridge is termed an *island*. In Galton's original definition, an "island" seems

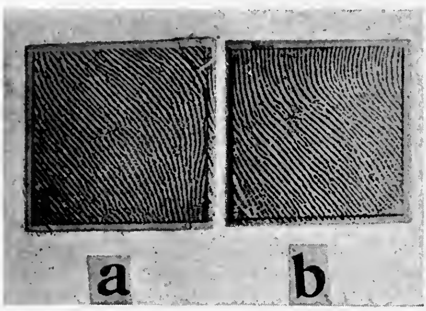


FIGURE 39a-b. Small squares taken from the prints of the left hands of two individuals (H. H. W. Coll: *a*, No. 346; *b*, No. 335). The squares measure 22mm. on the edge, and are taken from a particularly monotonous and featureless area, at the base of the metacarpal of the thumb, near the wrist margin. As shown here, the specimens are practically natural size.

to have been any short ridge, but it is better to use the term so far as possible in those cases only in which the ridge is a single unit.

Patterns, where the ridges form loops or whorls, or some similar figure, about a definite *core*, cover large portions of the friction skin, and are individually so different that even a novice seldom finds two that he cannot easily distinguish; in other regions, where the ridges run straight and parallel, and where there seems nothing distinctive to mark the skin of one man as different from that of any one else, if the attention be turned to the details of the separate ridges one finds here a field for an unlimited amount of individual variation, beyond all chance of being duplicated.

To show this a small square area was cut out from the same place in the hand prints of two individuals, as shown here in Figure 39, the place selected being one which has never occasioned any special interest among investigators, and where the ridges run monotonously in straight or slightly curved parallels. This area lies near the wrist margin of the friction skin, about over the proximal end of the metacarpal bone of the thumb. Some slight differences are seen in the print of the natural size, but by enlarging each about $2\frac{1}{2}$ times (Figure 40) the entire surface seems covered with

details which are far from any correspondence in the two samples. By a pure coincidence each bears a small scar near the center, across and over which the ridges have reunited, matching fairly well. The scar in *a* is that of a clean cut, healed by first intention; that of *b* shows the result of a more extended injury, with attendant suppuration. Both were, however, of a trivial nature, yet serve to show how such injuries leave their mark.

More important for our present inquiry are the striking differences in the frequency of special details, and in the relative size of the ridges in the two specimens; both points are best illustrated by the detailed sketch

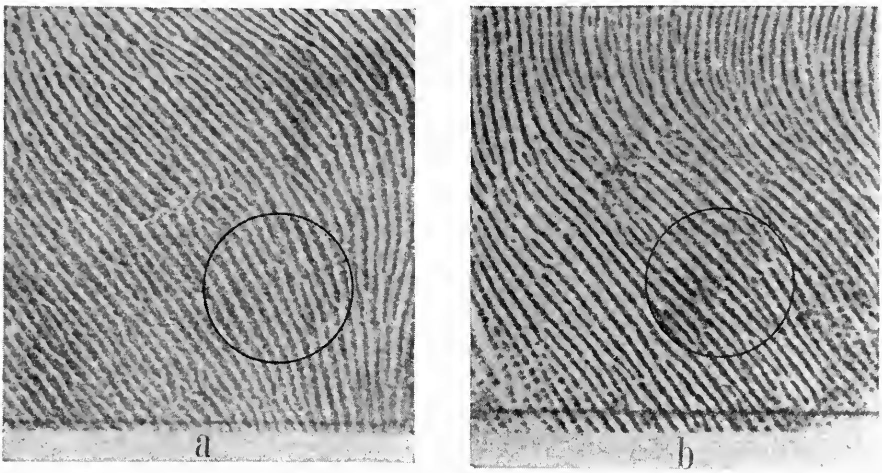


FIGURE 40 a–b. The squares shown in the preceding figure enlarged by photography $2\frac{1}{2}$ diameters. The richness of special features in *b* as compared with *a* may be easily seen. The circles indicate the region selected for still greater enlargement in the next figures.

of the more limited area enclosed by the circles. In these *a* shows 13 ridges, and 6 details, 5 being ends, and 1 an anomaly without name; *b* shows, in an area of the same size, 18 ridges (we count in both cases the ridges just appearing in the field, as well as broken pieces), with no less than 17 details. Of these 13 are ends, 2 are islands, and 2 interruptions, details not included in the Galton details as such, but conspicuous features, notwithstanding. The two hands from which these samples were taken are of the same size.

Thus here, where we are purposely studying friction skin in its least individual aspect; in a region known to be the most featureless and monotonous in the succession of ridges, a careful scrutiny of the prints, especially when aided by a slight magnification, shows such marked differences that even a beginner would have no trouble in distinguishing them at once.

If, instead of such an area, one were selected for comparison where the ridges are disposed in the form of a complicated pattern, and where, even at the natural size the dissimilarity is apparent to every one, it is plain that the chance of confusion would be very much less, and the comparison far simpler.

However, quite aside from patterns, that concern whole systems of ridges, *the Galton details, the ends, forks, islands and so on, are so numerous*

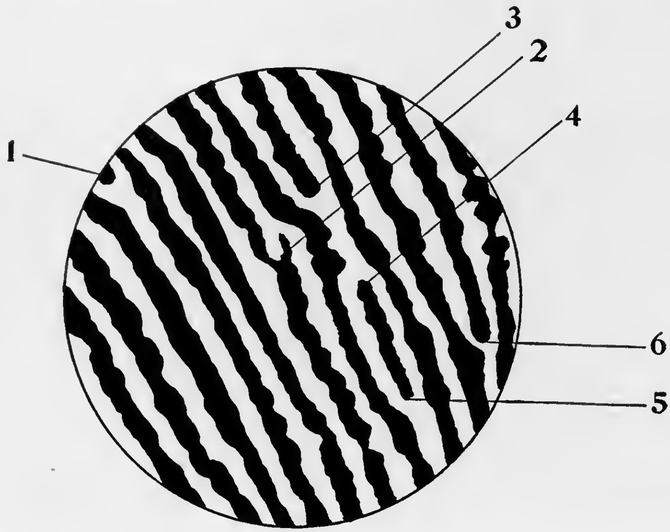
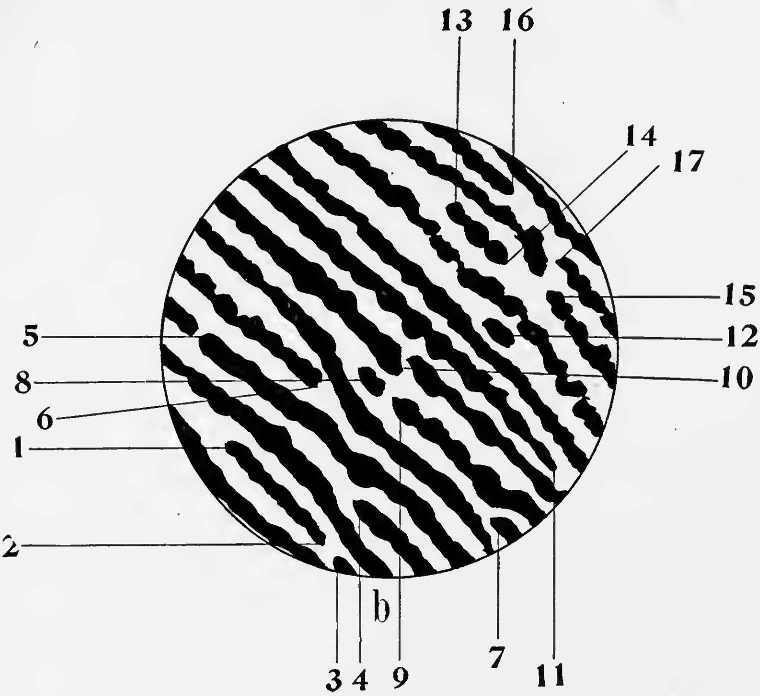


FIGURE 41a–b. Further enlargements of the friction skin shown in Figures 39 and 40.

(a) Detail of the area included in the circle in Figure 40a. Counting from the left, of the 13 ridges, ridge 4 barely comes into the field, ridge 9 is made up of short pieces, and ridge 12 is incomplete. The entire field is below the average in the number of features shown, yet displays five *ends*, besides a nondescript, but conspicuous detail on ridge 7.

and so variable that even in a small area a duplication is impossible. As the ridges are formed by the fusion of rows of units there is a possibility that during the formation a break might have occurred between any two of the units as marked by sweat pores, forming an end or an interruption. It is equally possible that islands or short ridges might have occurred at any point, or that a unit, instead of fusing lengthwise with its next neighbor, might happen to fuse across with the adjacent unit on one side and form a fork. Although it has been shown that the influence of heredity from parent to child is operative in the formation of similar patterns, viewed as a whole, yet there is absolutely no indication of such hereditary

control of the details of the individual ridges, and so far as we know all the infinite possibilities in the formation of the ridges are widely open in each individual case, so that it is quite safe to say that *no two people in the world can have, even over a small area, the same set of details, similarly related to the individual units.* Of course this is not capable of actual proof,



(b) Detail of the area included in the circle in Figure 40b. Including islands, and the tips of ridges along the margin, the ridge count is 18, showing a finer friction skin than in *a;* there are also 17 details. Thirteen of these are *ends*, two are *islands*, and two, *interruptions*, which, if counted as ends in the usual way, would count as four details instead of two.

Neither forks, nor inclosures, although of frequent occurrence, are found in either of these specimens.

any more than it can be absolutely proved that when a piece of written manuscript is torn in two it will not fit exactly any other piece than the one from which it was separated; but the two cases are about equal in the degree of probability. The only possible confusion might result from an area so small and so featureless as to show nothing but complete and parallel ridges, without details, but as far as our experience goes, such an area could not be much larger than the ones shown in Figure 39, and certainly could never occur in connection with the formation of a pattern,

where the ridges are called upon to make eccentric turns, and to fill up spaces of irregular shape.

As to the invariability of the friction skin throughout a man's lifetime, the second of the essential points in any system of absolute identification; although the first serious work in the field is now scarcely three decades old, something has been done in the way of direct observation, while important light has been thrown on the subject by the study of the development of the ridges in the human embryo. The results from both sources of information point definitely to one and the same conclusion, namely, *that there is and can be absolutely no change during life, either in the patterns, the individual ridges composing them, nor in the details of the ridges. Thus a system of identification founded on the friction skin possesses this second of the attributes required of a perfect system, the permanence of the marks throughout life.*

The first line of proof offered as a demonstration of this is the obvious one of collecting and comparing the prints of a given individual at various times during his life, and especially during the period of growth, when, if ever, changes would be expected to occur. For this we present here enlarged prints of the pattern of a little girl's right thumb, taken at the following ages: Four years, eleven months (Figure 42*a*); six years, eight months (Figure 42*b*); eight years, eight months (Figure 42*c*); ten years, six months (Figure 42*d*); twelve years, six months (Figure 42*e*); fourteen years, six months (Figure 42*f*).

From these enlargements, all of which are shown at the same magnification (2x), one has the opportunity to acquaint oneself with the individual ridges and with their details, and the reader can convince himself of the truth of our assertion concerning the permanence of the record. This special case is excellent for the purpose because of the presence of many *ridge rudiments*, or perhaps *incipient ridges*, that is, partially formed ridges, without sweat pores, or at least without many, placed in the intervals between the normally formed ridges, as though they had either been suppressed during early development, or else were new ridges in the act of formation. These objects have occasioned some speculation on the part of those who have studied the embryology of these parts, and the suggestion naturally arises in either case, if this process, whether of growth or of shrinkage, may not go on slowly during life, resulting ultimately in their disappearance or in their interpolation among the others as complete ridges. Perhaps in our present state of knowledge concerning developmental processes it might be best not to absolutely deny the possibility of some change in these structures before birth, or during infancy, yet, as shown here, no change, either progressive or retrogressive, has shown itself between the ages of four and fourteen, which includes the larger part of the growth period, when we might most expect such changes to occur.

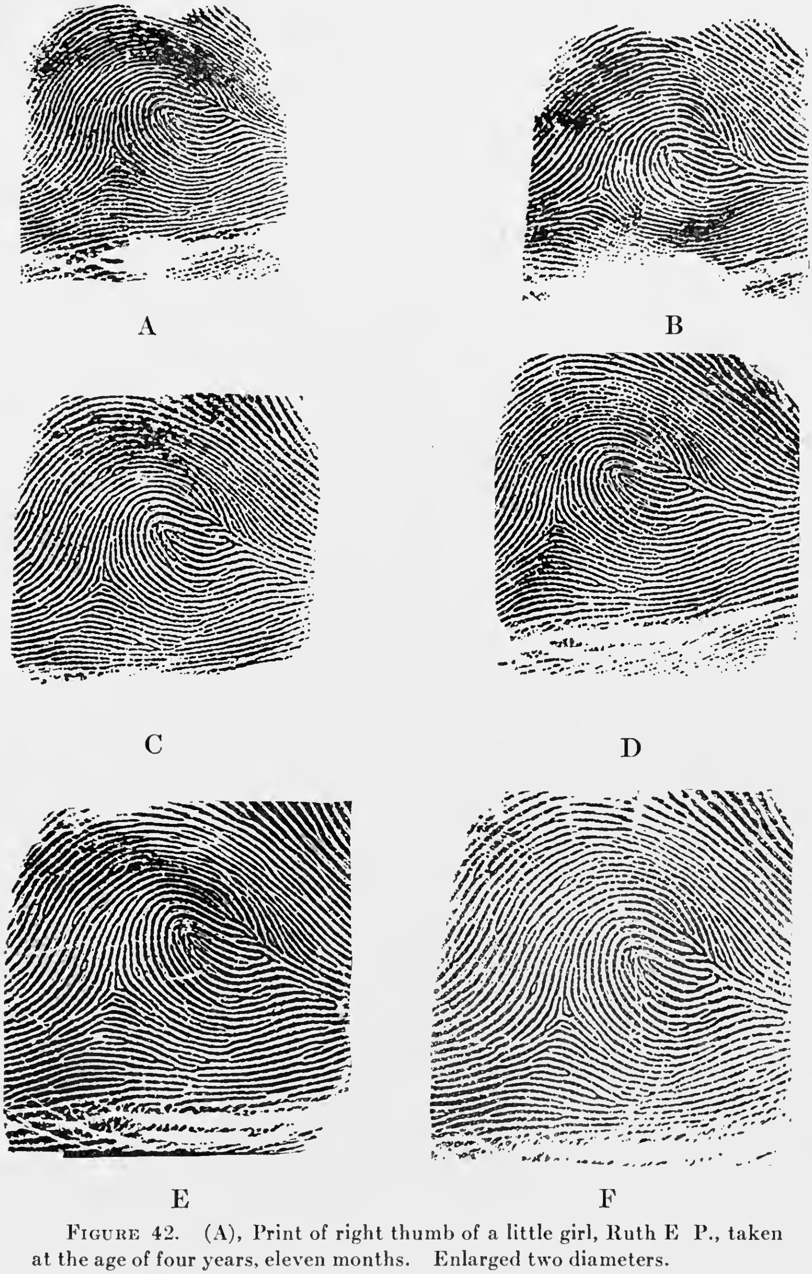


FIGURE 42. (A), Print of right thumb of a little girl, Ruth E P., taken at the age of four years, eleven months. Enlarged two diameters.
(b) Same as (A), and at the same enlargement. Age, six years, eight months.
(c) Same as (A), and at the same enlargement. Age, eight years, eight months.
(d) Same as (A), and at the same enlargement. Age, ten years, six months.
(e) Same as (A), and at the same enlargement. Age, twelve years, six months.
(*f*) Same as (A), and at the same enlargement. Age, fourteen years, six months.

Should it ever be found, however, contrary to present probability, that these incomplete ridges do change, it would not injure the effectiveness of the system, since they are rather unusual formations, always minute and inconspicuous, and would not affect in the slightest the larger configurations, such as the patterns, deltas, main lines, and so on, upon which the identification is mainly based.

Naturally the observations on permanence including the longest interval of time are those collected and published by Sir Francis Galton, the originator of the use of finger prints as means of identification. His investigations concerned the finger prints of some twenty-five persons, the time intervals ranging from 12 to 37 years.* The ages of life under observation included every year from two to 79, yet, *in all of the separate details which came under observation, 514 separate points in all, there was but one which was apparently different at different ages.* This was a case of the right thumb of a boy, taken at the age of two, and again at 13, and figured in "Finger Prints," on Plate 13.† In this pair 43 separate details, forks, ends, islands, etc., are examined and marked by numbers for easy reference, and in 42 of these there is a complete correspondence between the two ages, eleven years apart; in the 43d, however, there was a considerable discrepancy. At about the middle of an upper ridge, curving over the pattern, there is seen, in the child of two, a definite forking, producing a new ridge, which continues to the edge of the print. Of this extra ridge, in the older boy, not a trace remains; it is gone, fork and all. Considering the infancy of the first of these prints it is here possible that we are dealing with one of the suppressed ridges, shown in the little girl above illustrated; and it is possible that, although there is shown no loss of any of these after the age of four, one may now and then disappear at an earlier age. This possibility is strengthened by a careful examination of the print, as given by Galton, since, although the print is poor, one can see that the upper of the two ridges formed by the fork is extremely delicate and thin, and might easily disappear, giving the remaining one opportunity to straighten out, and become absolutely parallel to the adjacent ones, as appears in the boy of 13.

Galton's latest and most conclusive study of the permanence of ridge detail was made upon the finger impressions of eight Hindus, printed the

*Probably the longest interval during which the changeless nature of a finger print has thus far been noticed is in the prints of Sir William Herschel, from whom Galton got his first inspiration. In his book, published in 1916, Herschel presents fac-similes of certain of his finger prints taken at three successive intervals: in 1859, at the age of 26; in 1877, when 44; and in 1916, at the age of 83. Needless to say, no change can be found in any of these, although they cover an interval of fifty-seven years, the longest yet on record.

†Galton, F.; Finger Prints. (216 pages.) Publ. MacMillan, London, 1892.

first time in 1878 and next in 1892.* In spite of the fact that at the second printing the subjects were, many of them, quite old men, who naturally did not furnish very good prints, he found in two fingers of each, which were all he had, no discrepancy. The eight best sets out of the sixteen he made the subject of very special investigation, which he published in 1893 as a supplement to his work of the previous year, and reported as follows:

No. of the person	Finger printed from	Number of Agreements	Points of Disagreement	Pattern
I	Fore	9	None	Loop
II	Middle	5	None	Loop
III	Middle	21	None	Whorl
IV	Fore	19	None	Whorl
V	Fore	7	None	Loop
VI	Fore	19	None	Loop
VII	Middle	15	None	Loop
VIII	Fore	30	None	Whorl
Total		125	None	
Average		15.6		

Thus, out of the 125 points of resemblance, after a time interval of fourteen years, he found no differences; or, adding these to the 389 previously reported, he investigated 514 details, occurring after intervals of twelve years or more, and found but the single case in which the correspondence was not exact.

The testimony of embryology, although as yet this subject has not received the attention it deserves, is strongly corroborative of the idea of persistence, for at the earliest stage at which friction ridges can be recognized they appear simultaneously over the entire surface, covering it with a pattern quite of the adult type. This occurs at about the beginning of the fourth month of intra-uterine life, when the entire embryo is a little smaller than a new-born kitten, yet already the external details are fully formed. The hands, with each finger joint defined, could be drawn in outline within the limits of a common copper cent, but the palmar surface of both palm and fingers bears already the mark of each ridge, without doubt the very pattern which it is intended to carry throughout life.

This method of the sudden and direct shaping of the final ridges, without a preliminary period with separate units, is rather unusual in the development of an animal, since generally the embryo traces the important points in its evolutionary history, assuming in turn the successive stages in the order in which they probably appeared in the course of evolution.

*Galton, F.; Decipherment of Blurred Finger-Prints. MacMillan, London, 1893. A supplementary chapter to "Finger-Points," published separately.

Thus, at an earlier stage the human embryo possesses the gill-slits and pairs of aortic arches characteristic of fishes; and the respiratory and circulatory organs of man are attained through a roundabout course of development, during which the organs assume in turn the form and relationships of frogs and lizards. In some instances, however, as in the case of the friction ridges, an organ, or set of organs drops out the earlier stages in the development, and appears at once in its final form.

To summarize, now, the results of the study of friction skin, and to assert its claims to recognition as an ideal basis upon which to found a system of identification which shall be positive and absolute:

I. The palmar surfaces of the hand and fingers, and the plantar surfaces of the foot, including the toes, are covered with a special sort of skin, unlike that found anywhere else on the body. Its peculiarity consists of its being formed of minute ridges, having the mechanical function of helping to prevent slipping when in contact with smooth external objects. The ridges are hence called *friction ridges*, and the skin is best known as *friction skin*.

II. Over the greater part of the friction skin areas the ridges run in an approximately parallel direction, more or less across the longitudinal axis of hand and foot, but in certain definite places, where the surface rises slightly to come into fuller contact with external objects, there are found some decided departures from the usual course, and the ridges are arranged in loops, whorls, spirals, or some similar figure about a central core, which corresponds to the center or summit of the mound concerned. These are the patterns, which may occur in the following 11 places:

5 apical mounds (the balls of the digits).
4 interdigital mounds (on the palm or sole, beneath the intervals between the digits).
2 proximal mounds, the thenar and the hypothenar. (Thenar on the side of digit I; hypothenar on the side of digit V.)

III. *The patterns of the friction skin are individual, and, taken together, impossible to duplicate in another individual. The separate ridges, too, show numerous details, which are also so individual that a small area of friction skin, taken even in the most featureless portion, cannot be matched by any other piece.*

IV. Patterns and ridge details are developed in the embryo in what is probably their final arrangement. It has also been shown by repeated comparisons, taken at long intervals apart, that *even in the ridge details there is absolutely no change in an individual from birth to old age.*

V. This friction skin, with its innumerable individual marks, covers large and important areas of the body surface in four distinct places; the lower surfaces of the two hands and the two feet. These surfaces, or

at least some part of them, are more likely, for several reasons, to be preserved in case of casualty; the ridges reform after any injury short of one which destroys the lowest layer, or bed, of the epidermis; and thus the entire friction-skin surfaces can be destroyed during life only by a mutilation which would render the subject practically a cripple.

VI. Although any part of the friction skin is so individual that a positive identification could be made by its use, *the patterns, because of their complexity and striking differences, offer the best facilities for practical use.* Simple and efficient means have been devised for classifying and cataloging these and other salient features of the friction-skin surfaces, and these methods are easily learned, and simple in their application.

VII. In the practical application of friction skin as a means of identification it was found that *objects cannot be handled without leaving finger marks, or traces of them that can be developed,* and that these traces, if they belong to an individual whose prints are already on record, *will lead directly to the identification of the person who left them.*

VIII. Final Conclusion. *In the use of friction skin as a means of identification, we have something that fulfills all the necessary requirements.* It is (1) *individual,* and impossible to duplicate in another individual, (2) it is *a permanent bodily mark, never changing throughout life,* and (3) *it is marked in four important and convenient places,* with a different record in each place. To these may be added, (4) that *it is easy to devise an efficient system of classifying and recording them* and (5) *objects which a man has touched often retain a legible record from which his identity can be established.*

CHAPTER III

THE PALM OF THE HAND; METHOD OF DESCRIBING AND CLASSIFYING

"*On a dit depuis longtemps qu'il était impossible de trouver deux feuilles exactement semblable: jamais la nature ne se répète. Choississez n'importe quelle partie du corps humaine, examinez-la avec soin chez divers sujets, et les dissemblances vous apparaîtront d'autant plus nombreuses que votre examen aura été plus minutieux.*"*—*Alphonse Bertillon: Instructions Signaletiques, 1892. Introduction; p. XV.*

P*ALMAR CONFIGURATION.* The palm of the hand is wholly covered with typical friction skin, that is, with skin which is covered with fine ridges, something like corduroy; and here, as elsewhere, the ridges show the two important characteristics, that of *endless variation*, both of general pattern and of detail, and that of *absolute permanence* throughout life.

The most striking features of the general configuration of the palm are the traces of the original six patterns, the *thenar*, the *hypothenar*, and the *four interdigitals;* traces of at least one of the six are almost sure to be present, and occasionally there is a palm with all six. (See Figure 37, above; figure 44 shows all but one.) A given pattern, too, may show, in different hands, every grade of reduction from the primitive type, which consists of concentric circles surrounding a core, and surrounded by its three deltas, to the last vanishing trace of its last delta, as represented by the convergence of a few ridges at the proper point.

Primary Classification: The Four Main Lines. Although these patterns are noticeable features on a palm, and are of great use when running through a pile of prints to find a certain one, we have not found them advantageous to use as the basis of our *Primary Classification*, that is, the one first used in dividing a set of palm prints into its groups. A possible use of the patterns, when more detail is needed, as would happen with a very large print collection, is that of a *Secondary Classification*, and is outlined below; but for the first division, which would probably prove quite adequate in a collection, of the prints of not more than ten or

*It has long been said that it is impossible to find two leaves exactly alike: Nature never repeats. Choose no matter what part of the human body; examine it and compare it with care in different subjects, and the points of dissimilarity will seem to you the more numerous the more minute your examination.

twenty thousand individuals, the use of the *Main Line System*, with its descriptive formulæ, is recommended.

In this and other systems dealing with so large an area as the entire palm, it must be constantly borne in mind that we are dealing with much larger objects than finger patterns, and that, consequently, we are here to seek *a general configuration, and not the details or the count of the individual ridges. The ridges and their details are just as evident and just as numerous as on the finger tips, and they may be called upon at any time to corroborate a decision, or may be employed where the area obtainable is too small to allow the use of the whole palm; but in ordinary use a palmar description, or its formula, depends mainly upon the general course of a large series of ridges including patterns but not the study of ridge detail.* A photographic enlargement or even a magnifying glass are seldom necessary for an observer having normal vision, and an *interpreted* print, that is, one in which the Main Lines and other essential features have been marked by black or colored lines may be recognized at a glance, and has the individuality of a portrait. (Compare the illustrations given in this chapter.)

The starting points in the Main Line System of palm formulation are the four digital deltas, *a*, *b*, *c*, and *d*, placed on the palm just at the bases of the four fingers, *index*, *middle*, *ring*, and *little* fingers, respectively. These are readily seen in any print, and will doubtless be easy to locate in the reader's own hand. Each delta is the center of three radiating lines, or *radiants*, which continue the corners of the triangle formed by the delta itself. If these lines be marked on a print by a pen or pencil, preferably in color, it will be seen that two of them run up to the sides of the finger, and thus mark out a small triangular area at the finger base. The third, however, is more extensive, and runs over the palm, in some cases crossing the entire hand. This is a *Main Line*, and as one such proceeds from each digital delta, they are four in number, and may be designated by the capital letters, A, B, C, and D.

When these lines are all traced, a print will appear like Figure 43, in which the course of each Main Line has been followed. In this palm Line A, at the base of the index, curves strongly toward the thumb side, just escapes a large delta belonging to a pattern (hypothenar), and emerges at about the middle of the wrist, pointing up the arm. Line B curves the other way, crosses the palm higher up,* and emerges at the outer (ulnar) margin, perhaps two-thirds of the way up from the wrist to the finger base.

*In all words of direction it is assumed that the reader has the palm, in the form of a print, laid before him, with the fingers pointing away from him, toward the north in a map. In this position *up* and *upward* mean *toward the fingers* (north), or what anatomists call *distal;* while *down* and *downward* (south), mean *toward the wrist,* or *proximal.* The terms *inner* and *outer,* occasionally employed, mean respectively *toward the thumb side,* or *radial,* and *toward the little-finger side,* or *ulnar.*

Line C, always short in comparison with the others, takes an abrupt turn upward toward the fingers, and opens between the ring and little fingers. Finally, Line D runs in a direction opposite to the three others, curves

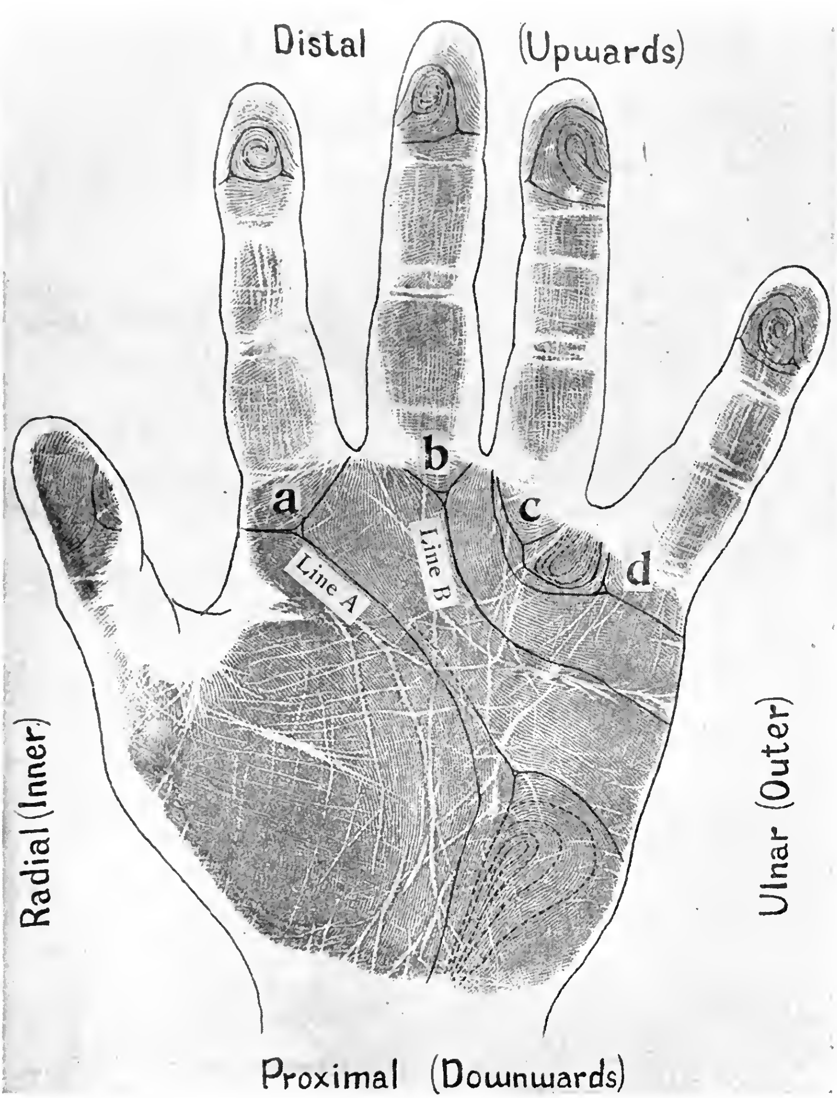


FIGURE 43. Print of an actual palm, with the Main Lines and other features marked, and used as a diagram to explain the method of *interpreting* a palm. Formula: 9.7.5.1.

gently upward, and emerges from the edge of the friction skin between the middle and ring fingers.

Quite a different course of the four Main Lines is seen in Figure 44, the right palm print of another individual. Here Line A opens to the

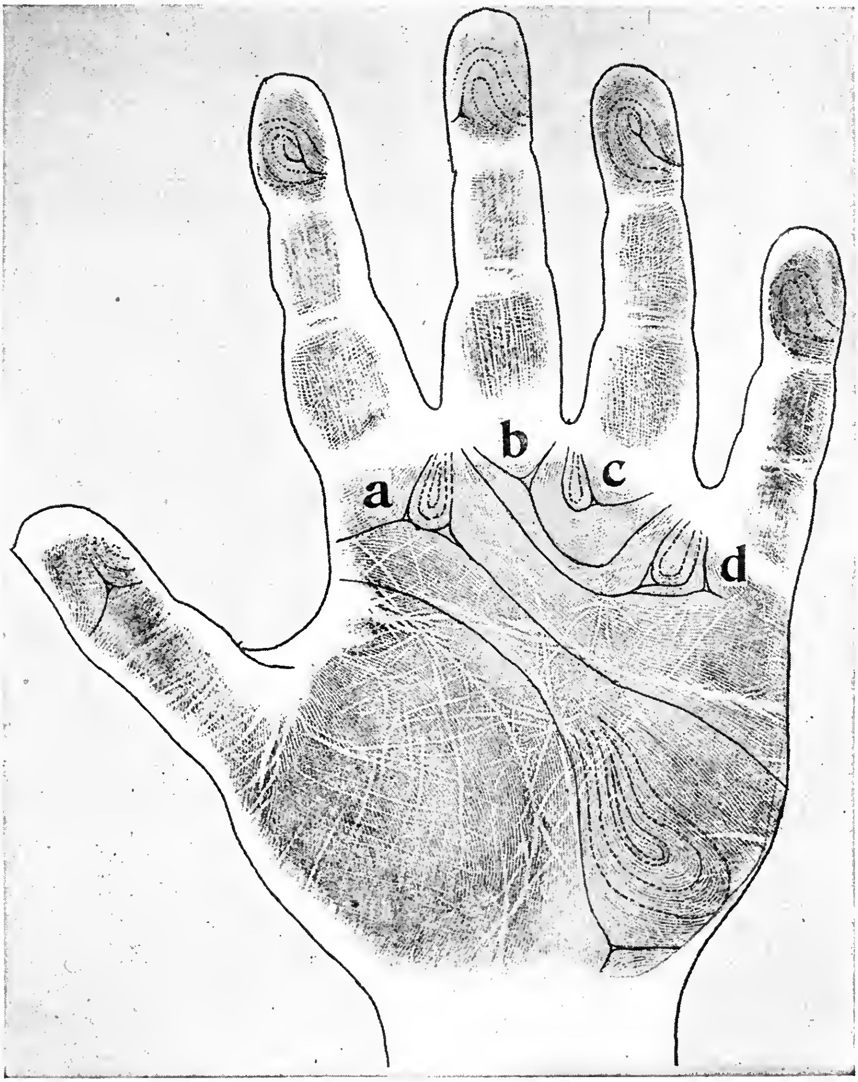


FIGURE 44. Print of an actual palm, *interpreted*, as in the case of Figure 43, but showing quite a different course of the Main Lines. This print has also all of the patterns to be found upon a palm, except the Radial (Thenar). Formula: 11.9.7.5d.C.

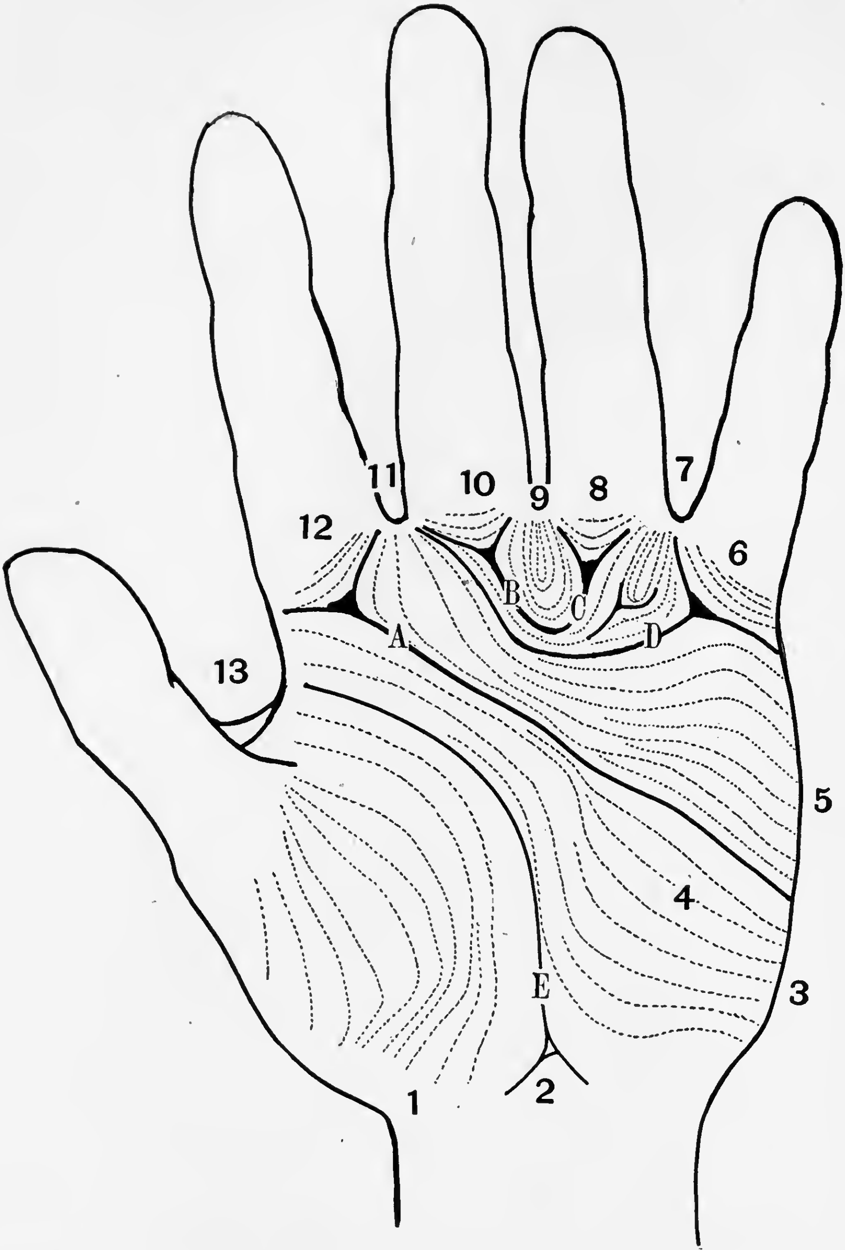


FIGURE 45. Diagram of a palm, giving the numerical values of the different parts of the margin. This diagram is the *key* to Main Line formulæ. Formula: 11. 10. 8.5. C.

outer margin; Line B between ring and little finger, Line C between the middle and ring fingers, and Line D between the index and middle fingers.

Thus, from these two examples, taken quite at random, it is seen that, (1) *there is much variation in the course of the four Main Lines, and* (2) *that their course could be indicated with considerable accuracy by simply designating the points along the margin where they terminate.*

Main Line Formulæ. For this, numbers are used, and the whole plan is seen on the accompanying diagram, which furnishes a complete key to the system (Figure 45). Beginning with the middle of the wrist there is here found either a typical delta, the *carpal delta,* or at least a parting of the border ridges, indicating its location. This point may be designated as 2. A hypothenar (or ulnar) pattern, *when present,* into which Line A frequently comes to an end (Figure 48) is called 4. The *d* delta, at the base of the little finger, is 6, that at the base of the ring finger is 8, the next is 10, and the next, 12.

The even numbers being employed to designate deltas, and other fixed points, the odd ones may designate the more or less extended margins between them; thus 1 represents the entire length of margin along the wrist border of the thumb before 2 is reached; 3 and 5, the very extended outer margin below and above the hypothenar pattern respectively. When this pattern is absent, 3 may be taken to represent the lower one-third of this margin and 5 the upper two-thirds. The inexactness of these values is compensated for in the formulation by reversing the terms, as explained below, thus placing less importance upon Line A.

Finally, 7, 9, 11, and 13 represent the four intervals between the five digits; 13 and 1, the two ends of the series, are separated by the thumb, which has no especial features, and never serves as a termination for a Main Line, but if a delta should ever be found at its base, as at the bases of the other fingers, it would be numbered 14.

By the use of this key the course of the Main Lines in Figure 43 would be designated simply by the four figures 1. 5. 7. 9. which would describe accurately their terminations along the margin. Now, as the starting points of these lines, from the digital deltas, is fixed and invariable, save for a slight shifting in some cases, and as lines of friction ridges never cross one another, these data so fundamentally describe the main configuration of a given palm that no great variation from it would be possible. To prove this, let the reader trace the outlines of a hand on a piece of paper, locate on it the four digital deltas, *a*, *b*, *c*, and *d*, locate also, from a given palm formula, the four terminations designated, and then draw out the four main lines, as thus conditioned, paying some attention to the usual way in which such lines curve, and he will find, by comparison, that he has drawn the distinctive features of the palm from which the formula was taken.

It has just been pointed out that the designations 3 and 5, which are used mainly, though not exclusively, as terminations for Line A, are not as definite as are the others. It may be also noted that Line A presents a greater monotony in its course than do the other lines, and for this reason, as the first term of the formula is of much importance in classification, *it*

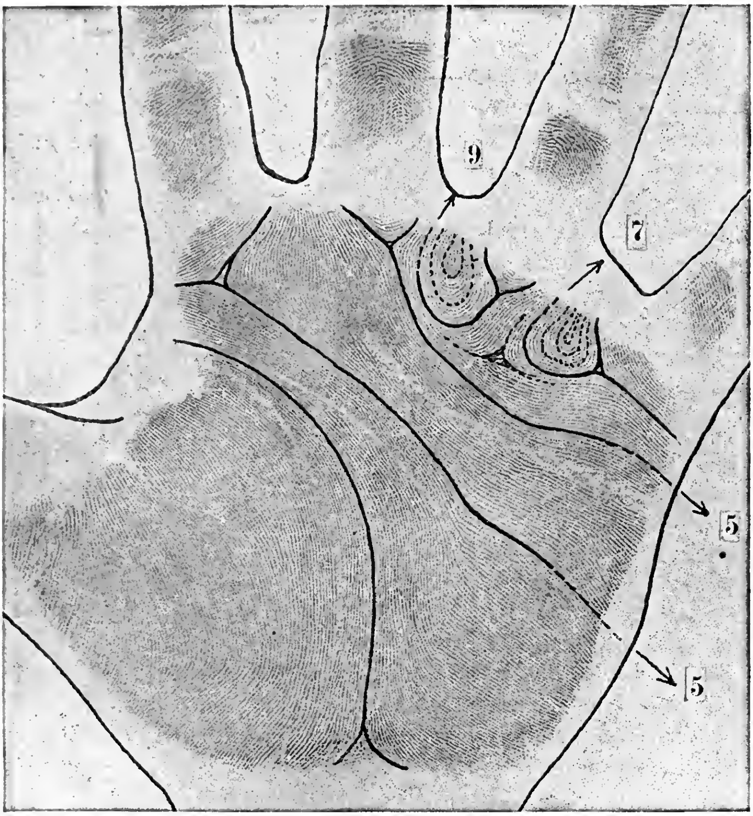


FIGURE 46. Palm print, with the formula: 7.9.5.5.C.

seems best to reverse the terms, beginning with D instead of A. Thus the formulæ for Figures 43 and 44, instead of reading:

1.5.7.9
5.7.9.11

should read:

9.7.5.1
11.9.7.5

Further examples of interpreted and formulated palms are given in

the next five figures, which may be considered in detail. When the Main Lines and other features have been traced on a print, as here, the print is said to be "*interpreted,*" and *such an interpretation must precede an exact formulation.*

Illustrations of Main Line Formulæ. Figure 46. Line D, with which we should begin, surrounds a definite pattern, its delta belonging to the pattern upon the outer side, while there is another delta present upon the inner. These two deltas thus frame in the pattern quite as is found in certain patterns of the finger tips, as described below. The Main Line D, also, is really a part of the pattern, but should be described by itself, as curving around the core of the pattern, turning rather abruptly upward, and opening between the ring and little fingers, that is, position 7. This gives the first term of the formula.

In some cases, as in Figure 49, this extra delta becomes directly involved in the D line, and in such the formula may be written with a small *d* as an exponent, placed to the right of the number for Line D, and a little above it. Here the delta, although conspicuous, is entirely separate from Line D. Line C also encloses a pattern, but again, as there is no extra delta involved, its termination, 9, is sufficient. Line B opens to the outer margin of the palm, but this is so high up that there can be no question of its inclusion within the upper two-thirds, and its designation is easily 5. With Line A there is a question, as its course terminates quite low, yet, by comparing the whole distance from the base of the little finger to the wrist, it seems a correct estimate to designate this also as 5.

We have, then, for the entire formula of Figure 46 the expression 7.9.5.5. To this may be added the letter *C*, which will indicate that a typical carpal delta is present.

Figure 47. This palm is, at first sight, somewhat hard to formulate, as the two deltas, *c* and *d*, are very near together, while the short connecting line is all that is left of the two Main Lines, C and D, fused together. As in all cases of the fusion of two Main Lines, however, each may be considered as ending (if sufficiently prolonged), in the delta of origin of the other (compare Figures 48 and 49), and thus here Line D ends in 8, and Line C in 6. Finally, Lines B and A both open to the outer margin, with a value of 5; and the formula stands, 8.6.5.5. As there is here no carpal delta, only a parting, this may be indicated by the letter P, placed at the end of the formula. A good hypothenar pattern is present, showing two deltas, but it does not come into connection with the main lines.

Figure 48. As Lines B and D fuse here, we get the respective figures of 6 and 10 for the two. Aside from this peculiarity, Line C is entirely wanting, a condition rather unusual but by no means unknown. This condition may be indicated by a cipher, 0. Line A is also peculiar, becoming wound up, or involved, in the hypothenar pattern, the condition

indicated on the key chart by 4. Finally, there is a carpal delta, placed high up, and connected with the hypothenar pattern. The entire formula for this palm is 10.0.6.4.C.

Figure 49. Here also Lines B and D are confluent, but the line passes

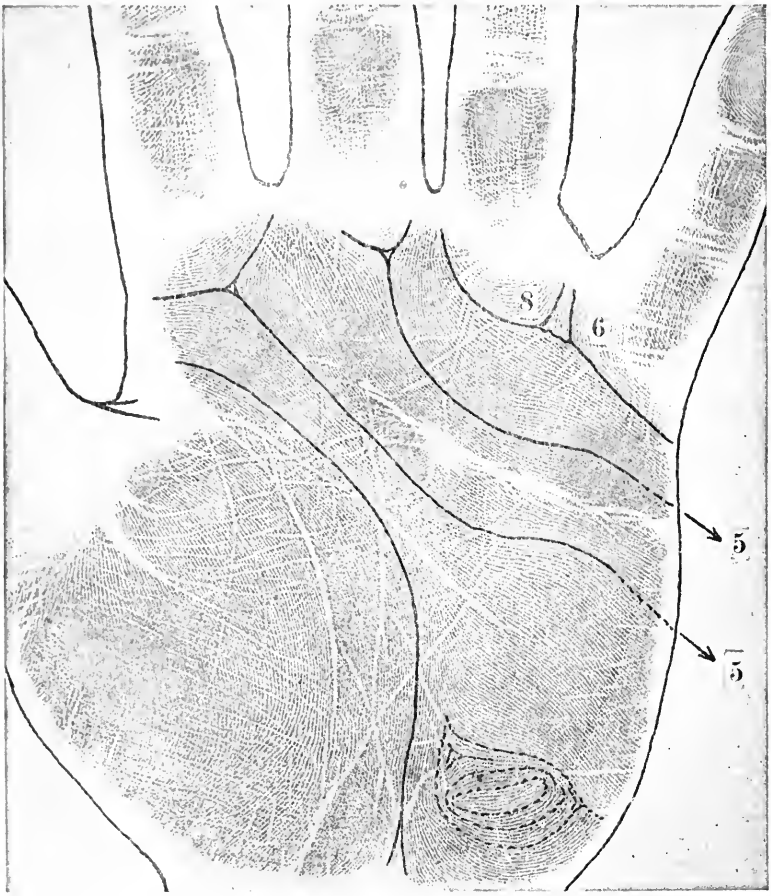


FIGURE 47. Palm print, with the formula: 8.6.5.5.P.

through an extra delta belonging evidently to the pattern near the *d* delta. Line C is present, curving up to the position 9; Line A emerges at 5, and there is a carpal delta, placed rather high. The formula runs: $10^{d}.9.6^{d}.5.C.$, the exponent letter *d* referring to the extra delta. Placing it in connection with Line B as well as D signifies that this line also might be considered to end in it, if it were not prolonged through it. The rather

unusual thenar pattern at the base of the thumb is indicated, but not well developed.

Figure 50. Line C is here small, and makes an insignificant loop toward the inner, or thumb, side of the palm. Both thenar and hypothenar patterns are present, also a carpal triradius. Formula: 11.9.7.5.C.

Aside from these actual prints, we present here a series of drawings

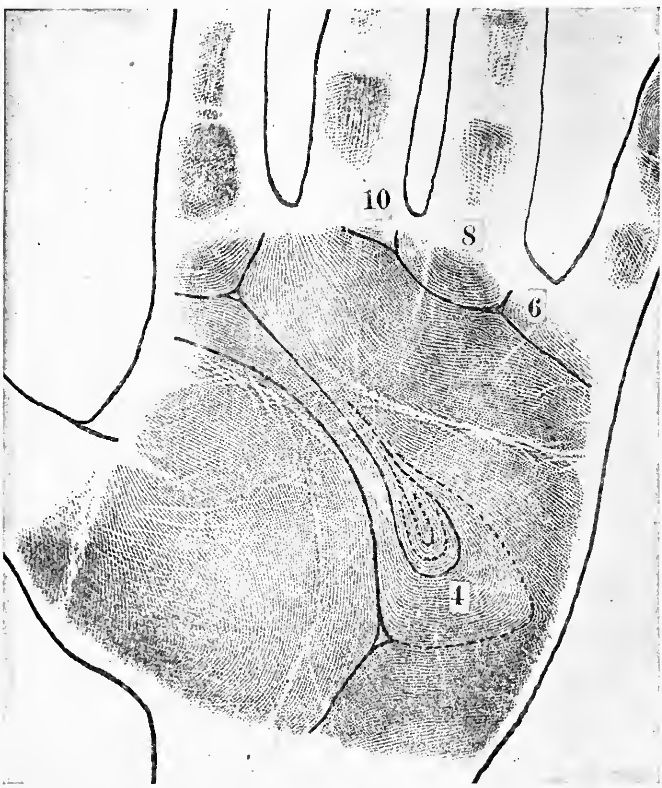


FIGURE 48. Palm print, with the formula: $10.0.6.4.C^{h}$.

taken from prints, and giving the lines which are essential for the delineation of the conditions. These are all taken from left hands, and the position of the fingers, which are not given, can be readily learned from the position of the four digital deltas. These may be considered in turn.

Figure 51. This figure shows the simplest formula possible, where Lines A, B, and C all run across the palm, approximately parallel to one another, and open out upon the outer margin in the position 5. In this case, which is by no means rare, Line D curves about in the only space

left for it, and runs into the space between the little and ring fingers. Formula: 7.5.5.5.P.

This formula, with its variants, 7.5.5.3, 7.5.5.2, 7.5.5.1, and 8.6.5.5, is of such great frequency in the negro race that one is almost tempted to call it the "Negro formula." It does occur, however, among

FIGURE 49. Palm print, with the formula: 10^{d}.9.6.5.C.

whites without a suspicion of negro blood, as here, but in nowhere near so large a proportion. In nearly 200 negro hands studied with this in mind, this group of related formulæ appears in 52 per cent, while in white hands it occurs in something like 10 per cent.

Figure 52. This hand, with the formula, 8.6.5.3.P, differs only a little from the previous one, since, by the change of a single ridge, Lines C and D, which here meet, might by a slight change pass one another, Line C passing below and reaching the outer margin. Line A, also, differs in position in the two.

Figure 53. In this hand, while A and B are simple to understand, each opening to the outer margin, with a value of 5, the relations of C and

D are very unusual, and might admit of more than one interpretation. As Line C occasionally disappears, with its delta, and there is but one delta here for the two lines, it seems easiest to assume that the missing delta is *c*, and that, consequently, Line C is also wanting. Granting this, the one remaining delta is delta *d*, and Line D swings around the entire C region,

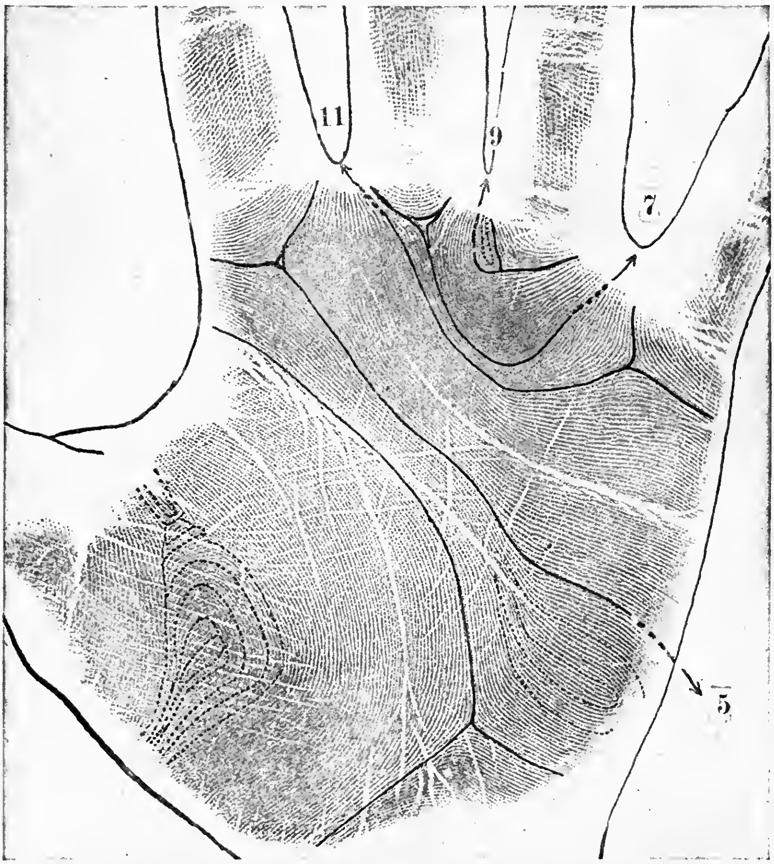


FIGURE 50. Palm print with the formula: 11.9.7.5.C.

where nothing is happening, and terminates between the ring and middle fingers with a value of 9. The complete formula, with this interpretation, runs 9.0.5.5.C.

Figure 54. The unusual thing about this palm, which strikes the eye at once, is the termination of Line A in the carpal delta (giving the value of 2 to this line). The formula is 9.7.5.2.C.

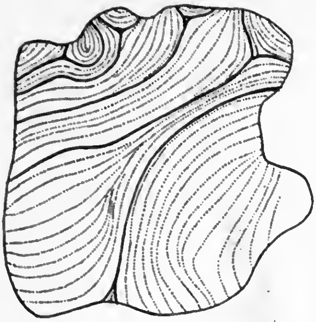


FIGURE 51

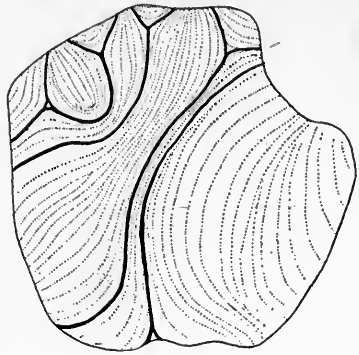


FIGURE 52

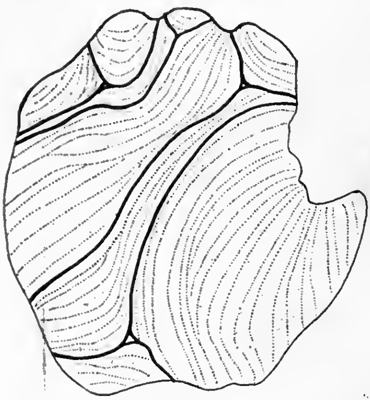


FIGURE 53

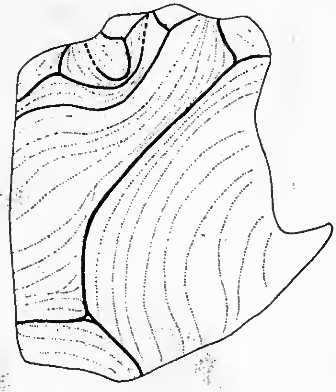


FIGURE 54

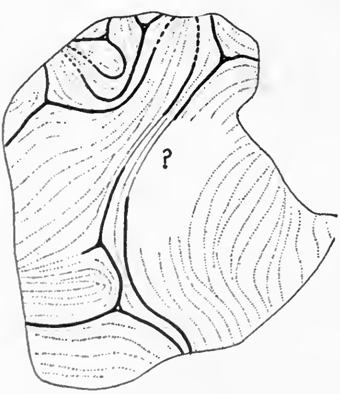


FIGURE 55

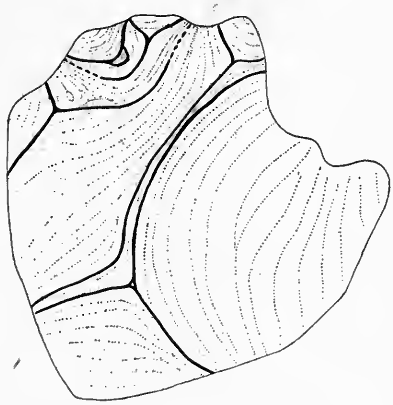


FIGURE 56

FIGURES 51 to 56. Tracings taken from actual palm prints, showing various arrangements of the Main Lines. The formulæ are as follows: —

FIGURE 51. 7.5.5.5.P
FIGURE 52 8.6.5.3.P.
FIGURE 53. 9.0.5.5.C.
FIGURE 54. 9.7.5.2.C.
FIGURE 55. 11.7.7.1.C.
FIGURE 56. 11.8.7.3.C^h.

Figure 55. Here the course of Line A turns toward the thumb still more than in the previous figure, and actually terminates between the carpal delta and the thumb; position 1. This is perhaps also its position in Figure 52, although in this case there is no carpal delta, and the exact position of point 2 is a little uncertain. This is an unusual course for Line A, and may be expected about twice in 100 hands. Formula: 11.7.7.1.C.

Figure 56. This was selected to show an unusual type of Line C, but shows also a pattern between Lines C and D, and has the carpal delta located very high up. As this latter is a distinct feature, it may be indicated, if one wishes, by an exponent letter *h* (high), placed in association with the term C, at the end of the formula, denoting the position of the delta in question. Line C, the chief peculiarity of this palm, forms a minute loop, which returns to the digital line, not far from its starting point, enclosing a single small circular ridge. As this line may be said to come back to itself (position 8), the value of 8 may be given to it. This is a very eccentric course for the line, but a similar case is frequently met with, where Line C runs straight into a loop, which terminates its course very shortly, and gives it no opportunity to continue to a margin. To this also, when it occurs, the value of 8 may be given. Formula: $11.8.7.3.C^h$.

Thus Line C shows three possibilities where the line does not reach any margin:

1.	Runs straight down into a loop, and stops,	=8
2.	Forms a little loop or circle upon its digital line,	=8
3.	Wholly absent, together with its delta,	=0*

Arrangement of Main Line Formulæ. In arranging a series of palm formulæ there is a very evident order in which they should be placed, namely, that of the numbers in their usual order, classifying them first by the first term, then, under each of these, by the second, and so on. Thus, in Figures 43 to 56, including the diagram, Figure 45, some 14 formulæ have been illustrated, with but one duplicate, that represented in Figures 44 and 50, and these two differ strikingly in their patterns. These 14 may be taken as an example of the proper arrangement in a file, and will be arranged as in the following list; the final term, C or P, would naturally follow the alphabet, and C would come first.

*As the digit O, standing alone, is a little awkward in a formula, and is liable to be confused with a 6 or an 8, the symbol X has been recommended for this condition (E. Loth, 1910). In the usage of this author X stands for either of these three alternatives; but a distinction might be made by using the 8 as suggested here, where a trace of the line is present, and the O to denote its complete absence. The formula for Figure 48 would then read, 10.x.6.4.C, and that for Figure 53, 9.x.5.5.C.

7.5.5.5.P	Figure 51
7.9.5.5.C	Figure 46
8.6.5.3.P	Figure 52
8.6.5.5.P	Figure 47
9.0.5.5.C	Figure 53
9.7.5.1.P	Figure 43
9.7.5.2.C	Figure 54
10.0.6.4.C	Figure 48
10.9.6.5.C	Figure 49
11.7.7.1.C	Figure 55
11.8.7.3.C	Figure 56
11.9.7.5.C	Figure 44
11.9.7.5.C	Figure 50
11.10.8.5.C	Figure 45 (Key diagram)

It is essential, for the practical purpose of seeing how such a method of describing palms would work, next to inquire into the number of different formulæ occurring, and the approximate frequency of each, and, although this can be definitely known only after the interpretation and classification ot many thousands, some little idea may be obtained by the following table, which gives the formulæ represented in the hands of 100 female students, taken at random, and computed for the right and left hands separately.

Formulae	left;	right	Formulae	left;	right	Formulae	left;	right
7.5.3.2.	1	0	9.8.5.5.	2	2	11.7.7.1.	1	0
7.5.5.2.	2	0	9.8.7.5.	1	1	11.7.7.2.	1	0
7.5.5.3.	6	1	9.9.5.3.	1	0	11.7.7.3.	1	1
7.5.5.4.	1	2	9.9.5.5.	2	3	11.7.7.4.	1	0
7.5.5.5.	2	2	9.10.8.5.	0	1	11.7.7.5.	8	4
7.9.5.3.	1	0	10.7.6.2.	5	0	11.8.7.2.	1	2
7.9.5.5.	2	1	10.7.6.4.	1	0	11.8.7.3.	1	0
8.6.5.2.	2	0	10.7.6.5.	3	4	11.8.7.4.	0	2
8.6.5.3.	9	4	10.8.6.3.	0	1	11.8.7.5.	4	3
8.6.5.5.	2	6	10.8.6.5.	1	2	11.8.9.5.	0	1
8.7.6.5.	0	1	10.9.6.2.	1	0	11.9.7.3.	2	1
9.7.5.1.	1	0	10.9.6.3.	1	0	11.9.7.4.	3	1
9.7.5.2.	3	1	10.9.6.4.	1	1	11.9.7.5.	5	23
9.7.5.3.	3	2	10.9.6.5.	2	2	11.10.8.4.	1	0
9.7.5.4.	1	4	10.10.6.5.	0	1	11.10.8.5.	1	5
9.7.5.5.	6	12	10.10.8.5.	0	1	11.11.8.5.	0	1
9.8.5.3.	4	1	11.7.5.3.	1	0			
9.8.5.4.	1	0	11.7.5.5.	1	0			

The total number of formulæ that were actually found to occur in this chance collection of 100 individuals (200 hands) is 52, of which 44 occur in left hands, and 34 in rights. Eighteen of the former appear in the left

hands alone, and not in the rights; 8 appear in rights only; while 26 are common to both. The commonest formula for the left hands is 8.6.5.3, which is found in 9 per cent of the 100 cases; for the right hands the commonest formula, and a very common one too, is 11.9.7.5, which is met with in no less than 23 times out of the 100 right hands, that is, 23 per cent.

From these comparisons we see *that the left hand is more variable than the right,* and hence should be used first in classifying prints; as it is a distinct advantage to have the first groups into which a set is divided as numerous as possible, and as equal as possible, results which right hands, with their smaller number of groups, and the single group with the formula 11.9.7.5, and including nearly one-fourth of all cases, would not effect. Undoubtedly a larger number than the 100 here used would yield many more separate formulæ, perhaps twice as many, and this would probably reduce the large proportions of the two largest groups.

Applying the results of this study, as thus far known, to the classification of a very large set of prints, 100,000 for example, and employing the numbers and proportions learned from the above table, the first subdivision, by the main line formulæ of the left hands, and allowing only the 44 different formulæ found in the 100 individuals, would subdivide the lot into as many different piles, containing, some 1,000, some 2,000, and a few a considerably larger number. The compartment reserved for the formula 8.6.5.3 would contain 9,000, the largest subdivision.

Suppose, now, still employing only the Main Line formulæ, each of these compartments were further subdivided by the right hands, and that these varied independently of the lefts, which they do, very nearly; each of the 44 compartments would be separated into some 34 smaller subdivisions, with about 230 showing the commonest formula in a compartment numbering 1,000. In the largest compartment, the one containing 9,000, there might be some 2,000 with this common right hand formula, and this would probably be by far the largest group in the whole collection.

But thus far only the four Main Lines have been employed, dealing with large and obvious features, which in an interpreted palm print, could be seen with the unaided eye across a room. We have, in fact, no more than begun with the endless number of individual differences in the human palm, any or all of which are available if desired.

Secondary Classification; the Patterns. In order still further to subdivide as large a collection as the one here imagined, recourse may next be had to the *patterns,* the presence of which is so marked a feature of a print. The presence or absence of the carpal delta also, or of others that sometimes appear in connection with the pattern, might be serviceable points for a further subdivision. These could be reserved for a collection of, say, a million individuals, where there would no doubt be several individuals with the same Main Line formulæ and with the same patterns;

but the presence or absence of the patterns alone would sufficiently divide the groups in any collection yet contemplated, and would be amply sufficient for present needs. It must be remembered, too, (1) that all these

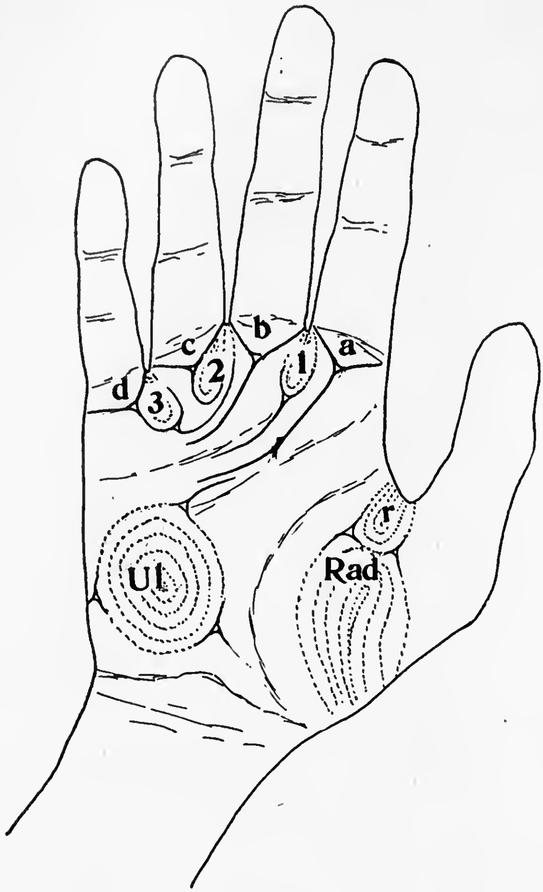


FIGURE 57. Diagram giving the location of the patterns, as used in determining the Pattern formula.

Ul, ulnar pattern; *Rad*, radial pattern; *r*, accessory part of the radial pattern, morphologically the first interdigital; 1, 2, 3, the three Palmar patterns; *a*, *b*, *c*, *d*, the four digital deltas, the starting points of the four Main Lines.

coarser features are to be employed only for the purpose of classification, so that a given print may be easily found among a large collection; and (2) *that the final question of identity, as in all identification by friction skin,*

comes from the examination of the ridge detail upon some selected portion of the surface, by which the positive identification or the reverse could be definitely and finally determined in a few minutes.

As above stated in several places, there are originally, or typically, *six* possible patterns on the palm of the human hand, one upon the inner cushion at the base of the thumb, the *Thenar;* one upon the outer cushion, on the little finger side, the *Hypothenar;* and four placed beneath the interspaces between the five digits, the four *Interdigitals.* Of these last the first, beneath the wide interval between the thumb and the index, is found only in connection with a thenar pattern, the two making a pair of loops, one opening up, the other down (Figures 24, 25). As it never occurs alone, and is so insignificant, and so closely connected with the thenar, it is best for practical reasons to ignore it altogether, and speak of this and the thenar, which always occur together, as one pattern. It is also more practical, in a working system, to find simpler and shorter words for the different patterns than the scientific terms used hitherto; and as an attempt to do this the *thenar*, on the side of the thumb, or the radius (the inner bone of the forearm) may be called the RADIAL; the *hypothenar*, on the side of the little finger, or the ulnar (the outer bone of the forearm) may be called the ULNAR, and the three *interdigitals*, which remain after disposing of the first, the three PALMAR.

Thus simplified, the *five* patterns of the human palm, with their names and positions, are indicated on the accompanying chart. It will be noticed that the three palmar patterns lie between the four digital deltas, *a*, *b*, *c*, and *d*, the first between *a* and *b*, and so on. This renders very simple the determination of each on a palm print, especially an interpreted one, covered by the Main Lines, *since none of the latter ever crosses a pattern, or even the area where a pattern belongs, but clearly defines and separates the three palmar areas, whether a pattern is on it or not.*

In expectancy of occurrence the Ulnar (hypothenar) pattern is found in not far from 20 per cent of the hands of white people, and the much rarer Radial (thenar) in not more than four or five per cent. Of the three Palmar patterns the Second is probably the commonest, the Third the next common, and the First the rarest. In the palm prints illustrating this chapter these five patterns may be found as follows:

Ulnar Pattern ....Figures 43, 44, 47, 48, 55.
Radial Pattern ....Figures 49, 50.
First Palmar ....Figure 44.
Second Palmar ....Figures 44, 46, 49, 50, 56.
Third Palmar ....Figures 43, 44, 46, 49, 51, 52, 54, 55, 56.

In some cases the determination of a given Palmar pattern is at first sight hard, since in proportion to the entire breadth of the palm they may

appear displaced. The exact determination, however, is always given beyond the shadow of a doubt by the four Main Lines, which frame in the pattern areas. Thus, in Figure 55 the Palmar pattern present appears about in the middle of the palm, that is, midway between outer and inner edges, and in an uninterpreted print might easily be called the Second. The establishment of the Main Lines, however, show conclusively that the pattern is really the Third, as it is included between Lines C and D. What has really happened here, as shown by the Main Lines, is that the Third Palmar area (with its pattern) has encroached considerably upon the Second, which is small and narrow, thus allowing its pattern also to encroach toward the radial or thumb side.

Having once learned the positions of the five patterns, the Pattern formula of a given print, in the form of a single number, may be easily obtained from the accompanying table.

SYNOPTICAL TABLE TO DETERMINE THE PATTERN FORMULA OF A GIVEN PALM.

Ulnar Pattern.	Radial Pattern.	Three Palmar Patterns.			
ULNAR present	RADIAL present	3 present	2 present	1 present	**1**
				1 absent	**2**
			2 absent	1 present	**3**
				1 absent	**4**
		3 absent	2 present	1 present	**5**
				1 absent	**6**
			2 absent	1 present	**7**
				1 absent	**8**
	RADIAL absent	3 present	2 present	1 present	**9**
				1 absent	**10**
			2 absent	1 present	**11**
				1 absent	**12**
		3 absent	2 present	1 present	**13**
				1 absent	**14**
			2 absent	1 present	**15**
				1 absent	**16**

ULNAR absent	RADIAL present	3 present	2 present	1 present	**17**
				1 absent	**18**
			2 absent	1 present	**19**
				1 absent	**20**
		3 absent	2 present	1 present	**21**
				1 absent	**22**
			2 absent	1 present	**23**
				1 absent	**24**
	RADIAL absent	3 present	2 present	1 present	**25**
				1 absent	**26**
			2 absent	1 present	**27**
				1 absent	**28**
		3 absent	2 present	1 present	**29**
				1 absent	**30**
			2 absent	1 present	**31**
				1 absent	**32**

The first pattern to use is the ULNAR, which, if present, directs the investigator to the upper half of the table, and consequently limits the designation to the first 16 numbers. This is followed by a scrutiny of the radial surface for the RADIAL pattern. The presence or absence of this rare pattern will definitely assign the palm in question to its proper subdivision; that is, to either the compartment at the head of the table, "*Radial present*," or the second subdivision, "*Radial absent.*" The next choice will be found in the third vertical column, and is based upon the presence or absence of the third PALMAR pattern, and in the same way, the fourth and the fifth columns, with their choices, based upon the two remaining PALMAR patterns, will lead eventually to a single number, somewhere between 1 and 32. This is *the Pattern formula.*

To illustrate by a definite case, we may find by the table the pattern formula for Figure 50 above. The presence of the ULNAR pattern, always the first point to be ascertained, limits the work to the upper half of the table, and fixes the formula between 1 and 16. The second question, that asked in the second vertical column, is also affirmatively answered in this case, and further limits the choice to the first 8 digits, included by the term "*Radial present.*" The third question concerns the third PALMAR pattern, which is here gone without a trace (between digital deltas *c* and

d), and limits the choice again to the four numbers 5 to 8. The second PALMAR, (the next question,) is present, and gives us only the choice of 5 or 6, and the last question, that concerning the first PALMAR, is answered by the expression "1 absent." This fixes the final choice at 6, the Pattern Formula for this particular palm.

Figure 49 starts with the lower half of the table, since it lacks the ULNAR pattern, after which it selects in turn the subdivisions "*Radial present,*" "*3 present,*" "*2 present,*" and "*1 absent,*" and thus reaches the number 18, its pattern formula. In writing out the entire description of a palm, it is best to use the Main Line formula, including the term for a Carpal delta or a parting, as a numerator, above the line, and the Pattern formula below; thus,

$$\text{Figure 50} = \frac{11.9.7.5.\,C}{6} \qquad \text{Figure 49} = \frac{10.9.6.5.\,C}{18} \qquad \text{Figure 46} = \frac{9.7.5.5.\,C}{26}$$

After working out the Pattern formulæ of a large number of palms the actual meanings of each of the 32 numbers will become so well known that a picture of the palm, with its patterns as they appear, will be readily imagined; yet, to begin with, it may be pointed out that all the odd numbers designate, among other things, the presence of a first PALMAR pattern; that the first half of the numbers, namely, 1–16, signify the presence of an ULNAR, while the second half, numbers 17–32, denote its absence; also that the first and third quarters of the numbers, that is, 1–8 and 17–24, possess a RADIAL pattern, while the others do not. It will thus appear that in a set of actual prints the 32 subdivisions are by no means equally frequent, that the numbers 17–32 will be much commoner than are the lower numbers (1–16); that of this latter half the numbers 25–32 will be much more frequent than the numbers 17–24, and so on. When it is remembered, however, that the whole Pattern formula is only a *Secondary* one, to be employed after the *Primary* classification by the Main Lines to subdivide further the larger groups, it will probably be found to be sufficient. It must be also noticed that these 32 subdivisions are those of one hand only, and if these be further subdivided by the Pattern formulæ of the other hand, it will make theoretically 32 x 32 possible compartments, or 1,024, into which to separate a set of palms having the same Main Line formula on each hand.

Thus far the palm system has never yet been applied to a very large number of individuals (about 800), and it cannot be predicted exactly where in the classification of a large collection the chief difficulties will come; the system, however, is elastic enough, and has a sufficient number of possible adaptations, to allow any inconvenience to be readily overcome.

If the prints of an individual are simply numbered consecutively as received in a given office, and placed on file in the same order, the Main-

Line-Pattern formulæ may be controlled by a card catalog of small-sized cards, which are themselves arranged according to formulæ. It would be even a comparatively simple matter to arrange two or more separate card catalogs, one classifying the prints in the collection by the left hands alone; the other by the right hands alone, to allow for the possible contingency of finding a single hand of a mutilated body, or to provide for the contingency of an individual losing a hand. Again it may be suggested that all schemes of classification are merely for the purpose of finding readily all the prints in a collection that resemble in general a certain one sought, and that the real *identification* comes, not from identical Main Line and Pattern formulæ, but in comparing the details of prints with the same formulæ to see if these too correspond. In this last trial every ridge, including its details, must correspond as closely as is demanded of a single finger print, and with so large an area as that furnished by even one palm the chances of such a correspondence between two individuals would be about the same as the chance of a stretch of wind-blown sand twice assembling each of its countless sand grains in exactly the same position relative to one another.

Although as yet the employment of the prints of human palms and soles has not been officially incorporated with the System of Finger prints, all plainly belong together, and in numerous cases the former could be used more advantageously than the latter. With the end of furthering this larger use of friction skin in identification, some calculation will be found, at the end of the next chapter, of the office furniture necessary for the installation of such a system on a large scale, especially the amount of space needed for an adequately equipped and classified collection of prints.

Interpreting a Print; Rules for this. Finally, although the "*interpretation*" of a given point, that is, the tracing of the Main Lines and other features is a comparatively easy matter, and requires only a moderate amount of either training or eyesight, certain simple rules may be here laid down to make the task easier for the beginner.

1. In general, a line is determined by following a single ridge which radiates out from a delta; but in places where the ridges are short and broken, it is sufficient to follow the general course. *A line must never cross a ridge.*

2. Whenever, through forks or breaks, there is doubt concerning the right ridge to follow, take the highest one, that is, the one highest up on the print when held with the fingers pointing up (north on the map). This rule is especially applicable to Line A, and to the others when they terminate in the outer margin, since here the ridges frequently multiply by forking, in order to accommodate themselves to the large Ulnar (hypothenar) area, which is supplied from a comparatively small number of

ridges that cross the palm obliquely from above. In this case always make the Main Lines in question terminate as high up as the ridges will allow. If the ridge that is being followed curves downward without breaking, it must be followed downward, as a complete break of continuity, so that the ridge comes to an end, is the only excuse for jumping up to the ridge above. Where a line terminates on the margin, however, the case is not very critical, as the margin indicated by both 3 and 5 is a long one; then, too, Line A is the fourth of the series, and the classification of the print is fairly well determined before the value of Line A is employed.

3. In cases where appearances indicate that two of the Main Lines will meet and fuse, start a line from each delta and follow each without prejudice. In doubtful cases, where the lines may be made either to meet or to pass by a ridge or two, favor the former decision, and cause them to meet.

4. Where, in the above case, the two lines cannot be made to quite meet, but where there is still some doubt whether another investigator might interpret the matter otherwise, indicate by an exponent upon each of the terms involved the other possible reading thus: $11^{10}.9.7^{8}.5$. This plan should be followed in all cases where another interpretation is possible, ignoring the exponents in classifying.

5. Where the deltas are not to be traced to a definite point and are rather indeterminate, the general convergence of ridges may be a sufficient guide to the starting point for the radiating lines.

6. Additional deltas, called "lower deltas," are frequently met with in association with the others, especially Lines A and D, and quite often, where one of these is present, the associated Main Line will run directly into it and stop, being continued only by one of the radiants of this new delta. In this case continue as the rest of the Main Line the radiant which in its direction forms the most natural continuation of the Main Line, and indicate the presence of the delta along its course by an exponent letter *d*, as shown in the formula for Figure 49 ($10^{d}.9.6.5.$C.).

7. The above rule does not hold for Main Lines which run into either the carpal delta or that belonging to the ULNAR pattern, since these bear respectively the numbers 2 and 4, and form regular points in the system, as shown in the key diagram, Figure 45.

CHAPTER IV

THE SOLE OF THE FOOT; METHOD OF DESCRIBING AND CLASSIFYING

"*It happened one day, about noon, going toward my boat, I was exceedingly surprised with the print of a man's naked foot on the shore, which was very plain to be seen in the sand. . . . I went to it again to see if there were any more, and to observe if it might not be my fancy: But there was no room for that, for there was exactly the very print of a foot — toes, heel, and every part of a foot." — Daniel DeFoe (1659–1731): Robinson Crusoe.*

IN the complete exploitation of a system of identification based upon the friction-ridge configuration the soles of the feet should not be neglected; for not only is the general configuration often more elaborate and certain patterns more constant than in the palm, but there are numerous cases in which there is a distinct advantage in the use of the sole rather than any other parts.

Thus, identification by sole prints is by far the most practical method for use in identifying the babies in maternity hospitals, since the printing of either fingers or palms is practically out of the question because of the intense and constant activity of these latter parts. The movements of the parts of the foot are limited, and the toes are too short to interfere so that a set of fairly good sole prints may be made with comparative ease in even a new-born baby. Here, as in all cases where the ridges are fine and soft, very little ink should be used, spread over a small glass plate, and the foot, held firmly in the hand in a natural position, should be applied quickly and lightly, first to the glass plate, then to a pad of glazed (or ordinary) paper. Good prints may also be obtained by rolling an inked rubber roller over the sole, and then applying the paper, but in the long run it will probably prove to be less practical than the other method.*

A second important application of sole prints comes in the case of badly mutilated bodies, such as result at times from railroad and steamboat accidents, theatre horrors, mill disasters, and so on, where there has been a burning of the surface, or perhaps a complete dismemberment, with recovery of isolated limbs. Here the protection offered by the shoes

*The use of infant footprints for identification has already been inaugurated in the Chicago Lying-in Hospital, by the Superintendent, Miss Christie, but thus far their use is wholly supplementary to the more usual methods, and there seems to be, so far as the authors can learn, no attempt at interpreting or indexing them.

and stockings will frequently preserve the sole, or a portion of it, when the face is entirely unrecognizable, and where finger prints can no longer be obtained. In the novel of Sir Walter Scott, "The Fair Maid of Perth," which depicts mediæval Scotland, much of the plot turns upon a severed hand, found on the pavement after a street brawl, but had the Palm System, described in the previous chapter, been in full operation, there would have been no mystery whatever. In the same way, given an established classification of citizens based upon the soles, and operated in the same Bureau with the rest, a severed foot from a factory explosion could be promptly and completely identified. This would thus be analogous to the recent Scotland Yard case, related in Chapter VI following, where a burglar left a little finger upon a high gate, torn off as the criminal attempted to escape.

One would naturally think that in temperate climates, where shoes are so universally worn, there would be practically no need of the study of the bare foot for chance impressions connected with crime, as is so frequently done in the case of the finger prints; yet it is not infrequent that a malefactor commits his crime barefoot, in order to move more silently, and to feel the ground in the dark. In the tropics, in dealing with the habitually barefooted natives, the study of bare footprints, and of their ridge patterns, would be of much importance.

Because of the neglect of the use of sole prints, or any part of them, for purposes of identification, there has been as yet no published attempt to reduce these complex areas to formulæ, or to classify them in any way.* A system based on that above given for the palm of the hand is not feasible, mainly because, unlike the hand, the friction skin of the foot extends, with important parts of the general pattern, some distance up on the sides, and hence does not print in an ordinary contact impression. This may be seen in part by comparing this *Tread-Area* impression, or one produced by placing the foot upon a piece of paper as in simply stepping or standing, with a *Rolled Print*, or one produced by rolling the foot, both for inking and for printing, from one extreme edge to the other. Even in a rolled print, however, the region between the ball of the foot and the ends of the toes is wanting, and it is here that the four digital deltas, necessary for locating the Main Lines, are frequently found. Occasionally these four points lie within the bounds of the tread area (Figures 58–60) and the four main lines may be easily followed, but it more often happens, as in Figures 70, 71 and 72 that the digital deltas, or some of them, lie

*A popular article, dealing with the study of the print of the bare foot in the detection of the agent of a crime, written by Melville Dawson Post, has recently appeared in the *Saturday Evening Post* (Feb. 3, 1917), but deals with proportions and the indications of habitual posture and gait. It is, however, of great interest to the authors as perhaps the first attempt to direct attention to the subject, and shows the present necessity of considering the ridge conformation of human soles.

above the contact area of a tread impression, and that the main lines are thus impossible to locate.

Again, even although this difficulty were overcome, as by some device that would print the entire surface, the main lines, when followed, are almost always unsatisfactory. Often, as in Figure 58, the main lines come together at their terminus in the margin, or actually fuse, making a very monotonous formula; in other cases, what with their becoming wound up in patterns (Figures 60 and 69) or becoming implicated in the so-

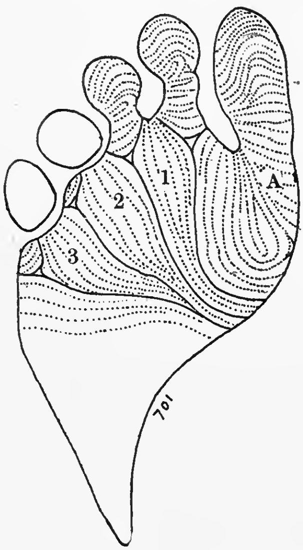


FIGURE 58. Tracing from a left-sole print. All the digital deltas are present, and the three plantar areas are easily and distinctly separated from one another. Formula: A 1.

called *lower deltas*,(Figures 59 and 60) their course is so complicated as to defy any simple method of expressing it.

After making numerous attempts, each of which worked with more or less ease until confronted by some peculiar case, hitherto not known, the authors have decided to publish the one that here follows. It may not allow of sufficient subdivision to avoid some congestion in the case of the commonest formulæ, but it possesses the advantages of being simple, and of being easily applied to the ordinary tread area, without requiring a rolled print. Beyond the scope of this system, which concerns itself wholly with the larger and more obvious features, there still lie the infinite possibilities of the ridge details of the patterns, particularly those of the *Ball Pattern*, and these, after some few suggestions, may be

left to a later investigator, after the use of the sole becomes of general use and of serious practical importance.

To begin the study of the sole, prints should be obtained in which, like Figures 58, 59 and 60, the digital deltas are well within the boundary of the usual print, and where they can be easily seen. From these the four Main Lines should be extended until they either run over the margin,

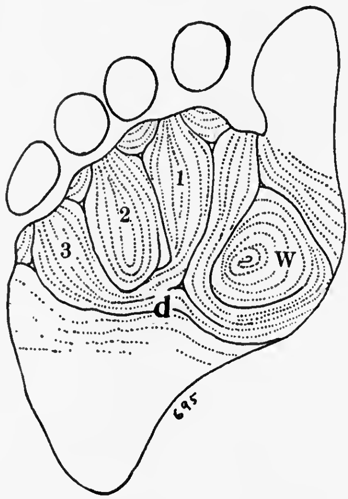


FIGURE 59. Tracing from a left-sole print. All the digital deltas are present, yet the division of the plantar region into its three areas is not so simple as in Figure 58, partly because of the presence of a lower delta. One of the upper radiants of this latter runs directly into the first digital delta, and thus clearly separates the first plantar area from that of the Ball pattern, but its outer upper radiant runs through the center of the third plantar area, and is thus of no assistance in delineating the areas. Formula: W 5d.

as in Figure 58, or become involved in a pattern or lower delta, as in Figures 59 and 60. These serve to divide the entire "ball of the foot" into four areas, any or all of which may be quite plain and without patterns, or may be each covered by a regular pattern, with definite core (compare Figure 58 with Figure 60). These patterns, or the corresponding areas, may be termed, going from the inner to the outer sides, the *Ball Pattern*, and the three *Plantar Patterns* (1, 2, and 3).*

*Matters pertaining to the palm are called *palmar*, and those pertaining to the sole, *plantar*, from the two Latin words: *palma*, the palm, and *planta*, the sole. The three areas, frequently marked with a pattern, lying in the palm beneath the fingers,

The first, the *Ball Pattern,* is almost always present, and presents several typical forms; the three *Plantar Patterns* are more uncertain in occurrence, and may occur in any combination, such as either alone, 1 and 2 united, 1 and 3, 2 and 3, or all. In form they may appear as complete

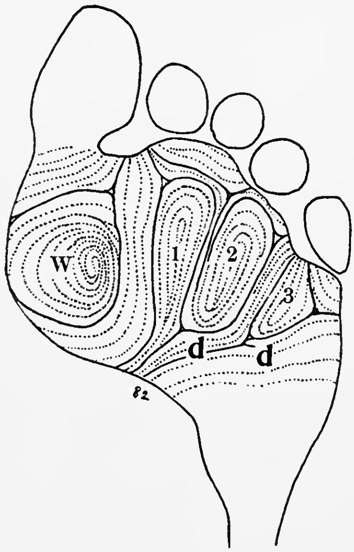


FIGURE 60. Tracing from a right-sole print. Here the four digital deltas are all present, but the digital areas above them are partly fused, and their lower radiants (the "Main Lines" of the palms) are complicated in their relations, becoming implicated in lower deltas. Nevertheless, the three plantar areas, with their patterns, are very evident. Formula: W 46dd.

oval figures, i. e., *whorls* (Figure 60, 2, with an S-shaped core) or as *loops;* and in this latter case the loop may open either way, up or down (Figure 60, compare area 1 with area 3).

If, after a little practice with prints in which the digital deltas are clearly seen, he next turn to others with little or no indications of these points, he will see that, as in Figures 70, 71, and 72, the three plantar areas

are thus correctly termed the *Palmar Areas,* and the corresponding areas on the sole of the foot the *Plantar Areas.* There are many close correspondences between hand and foot, making it almost a pity that similar parts are distinguished by different names. The great toe and the four lesser ones precisely correspond to the thumb and the four fingers, yet if we confine ourselves to English we have the two sets of names to deal with. In this case, however, we have the Latin word, *digitus,* anglicized to *digit,* which may refer to any one of the whole twenty, and this word is frequently used here in this general sense.

may still be located with some accuracy, and that there is never serious danger of confusing one with another. Where, as in Figure 72, a lower delta spreads out its two upper radiants so wide that they take in more ridges than belong to a single pattern, there is some chance of overvaluing the territory that belongs to a single area, but there is even then but little opportunity for misnumbering a pattern core that shows itself in that place. In this Figure 72, for instance, a disturbance in the course of the lines included within the radiants of the lower delta indicates clearly that both 1 and 2 are brought within the embrace of this widely expanding triradius;

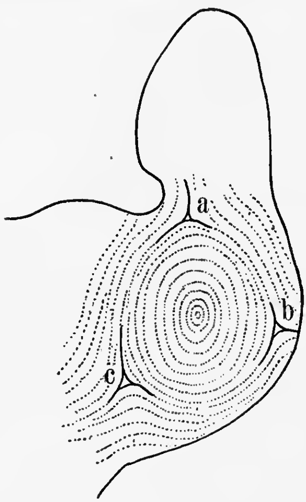


FIGURE 61. Diagram of a typical Ball pattern, of the whorl type, showing the three original deltas, surrounding the pattern, and embracing and defining a *pattern area*. Imagine either of the three deltas to be removed in turn, and the pattern will become a loop, opening upwards, if *a* is removed; inwards (*i.e.*, toward the inner, or great toe side of the foot) if *b* becomes lost; and downward and outward (*i. e.*, toward the little toe) if *c* is removed.

similarly, in Figure 69, the second area, without any such reason, has widened far beyond its usual proportions, and all but crushed out of existence the third area, indicated simply by converging lines. *Should one be working upon a basis that demanded an exact set of boundaries for these three plantar areas, cases would frequently be met with where there would be much uncertainty, but if a system calls only for determining the presence or absence of each of the three patterns, without regard to the areas themselves, there is no likelihood that a really serious difficulty would ever be met with.*

The system which the authors present here is therefore based upon the detail of the pattern upon the BALL AREA, the presence or absence of patterns upon the THREE PLANTAR AREAS, and the presence or absence

of LOWER DELTAS; all being points which can be readily ascertained upon a tread area print, and are in no way dependent upon features of uncertain occurrence. This system, presented as a proposal to be put to later test, and then accepted, modified, or abandoned, as the results suggest, is as follows*:

Method of Formulating Sole Patterns. To start with, the best and most obvious point of departure is the pattern on the ball at the base of the great toe, the *Ball Pattern.* As the main weight of the body is sustained here and at the heel, the ridges covering these two surfaces are

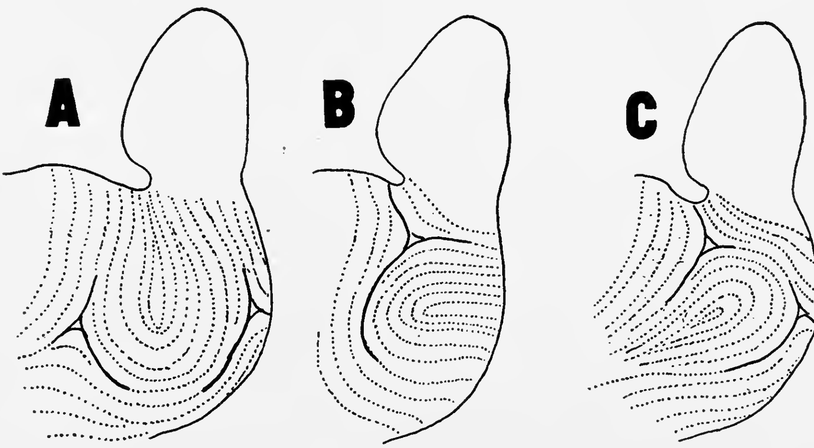


FIGURE 62. The three types of loops found on the Ball area, caused by the failure of the respective deltas. Compare with Figure 61.

especially strong and heavy. It happens also that the Ball Pattern is not only nearly always present, but is very variable, and that further, these variations can be readily classified into certain definite types.

In its most complete form, this pattern appears as a *Whorl,* quite similar to the finger-tip pattern of the same name, except that it is here surrounded by three deltas, instead of two. (Figures 59, 60, and 72.) In its most typical form (Figure 61) the ridges form concentric circles about the center, and its three deltas are placed at equal intervals about it, each with two radiants helping to surround the core, while the third is pointed away from it. These deltas may be designated as *a*, *b*, and *c*, as indicated, *a* being above, *b* along the inner edge, and *c* below and outward, toward the smaller toes. It seldom appears in this typical form, however, but exhibits numerous variations of the deltas, the radiants, and the core.

*As we always hold the print of a sole, as we do that of a hand, with the points of the digits directed upward, the terms of direction, *up, down, outer, inner,* etc., can be used alike in both cases, without confusion. *Up* and *down* are more convenient for general use than the more scientific *distal* and *proximal,* which mean respectively *toward*

To begin with, it may be imagined that one of the deltas may be wanting, and that, as the ridges are no longer confined at that point, they gush or flow out in the direction of the break. We may thus have *Type A*, in which the *a* delta is wanting, and the ridges flow upward, between the great toe and the next; *Type B*, where there is no *b* delta, and where the ridges flow toward the inner margin of the foot; and finally *Type C*, where the *c* delta fails, allowing the ridges to flow across the foot, downward and outward. These three types actually occur, Type A vary commonly, Type B rather seldom, while Type C is extremely rare. (Figure 62).

Type A is shown in Figure 58 and Type B in Figure 69. The whorl, the original type, designated as W, is shown in such cases as Figures 59 and 72. Aside from all these, the Ball Pattern may be entirely wanting, or represented merely by a convergence of ridges, without a core, and this condition may be designated simply by an "O." (Figure 68.)

By following the above directions the great majority of Ball Patterns may be easily classified as A's, B's, C's, W's, or O's, but there remain a few which, from some modification of the core, do not so plainly fall within these five types. (Examples, Figures 63, 64, 65, 66, and 67.) As is done in the case of the finger patterns, these are all classed as whorls; an exponent letter, placed to the right and a little above the W designating the particular variety. So far as is known, all such departures will come under one of the following cases, and will be written W^{sm}, $W^{L.P.}$, $W^{T.L.}$, and so on.

sm = a seam, where a number of ridges come to an end along the same line, and abut upon a system of ridges going the other way; often seen in connection with the "A" delta.

a, *b*, or *c;* a modified whorl approximating either type A, B, or C, as given below.

L. P.; a whorl composed of two interlocking loops, the cores of the loops, entering the field of view from the same side; (= a "Lateral Pocket," Figure 66.)

T. L.; a whorl composed of two interlocking loops, the cores of the loop entering the field of view from opposite sides; (= a "Twin Loop," Figure 65.)

C. P.; a loop with a pocket in its center, having one or more recurving ridges, thus putting a pattern so designated in the whorl class; (= "Central Pocket.")

S = a whorl, the center of which is in the form of an S-shaped figure.

In this latter case the core of the whorl, instead of consisting of concentric ovals, as would be found in a typical pattern of this type, becomes modified to form an S-shaped figure of greater or less extent. When small, as in Figure 60, it would naturally be expressed as still an almost

the tips of the digits and *toward the body;* and although these latter may be always applied, no matter in what position a print is held, one can soon get into the habit of always holding a print with the fingers or toes pointing to the top of the page, in which case the simpler terms, although relative, will cause no confusion. This is similar to the universal modern method of holding a map with the direction *north* at the top, unless otherwise specified.

typical whorl, with a modified center, or W^s. When, however, the S-figure becomes so large as to involve practically all the ridges of the pattern, as in Figures 63 and 64 it will be seen that these whorls are composed of two interlocking loops. These may be designated by the exponents T. L. for the *Twin-Loop* (Figure 65), a composite where the cores seem to enter the field of view from opposite sides; or L. P. for the composite called *Lateral-Pocket* (Figure 66), where the cores enter from the same side. Again a ball pattern may appear as an A loop, having a pocket in its center

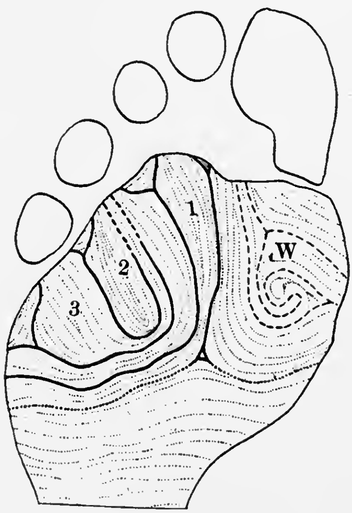


FIGURE 63. Tracing from the print of a left sole. The four digital deltas are all present, but the radiants that help in separating the three plantar areas assume a very erratic course. The location of the three areas is, nevertheless, clear, and the pattern formula can be readily made out. The ball pattern is a twin loop. Formula: $W^{T.L.}$ 5d.

with one or more recurving ridges, a *Central Pocket* (Figure 67). Such patterns also are considered as whorls and the exponents C. P. are used to indicate them. Care must be taken to make sure that the ridges around this pocket recurve; for many times converging ridges will have the same general appearance, and may be differentiated only by the use of a magnifying glass. Loop Patterns, with no recurving lines regardless of their general appearance, will remain in the loop class.

Such difficult cases occur also in finger prints and in all systems founded upon patterns, and, to use an illustration of Galton's, cause about the same amount of difficulty as do such surnames as the *Macs* and the

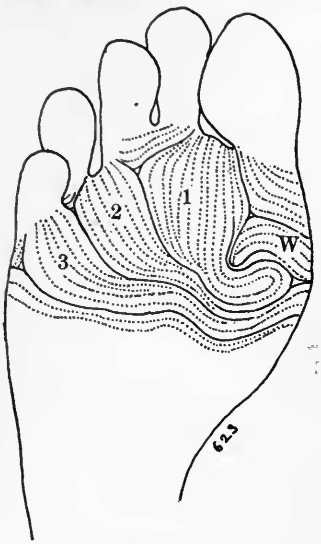


FIGURE 64. Tracing from the print of a left sole. The three last digital deltas are present, but the fate of the first is uncertain. Although unusual, and quite out of place, the shape of the ridges in the region of the first plantar area suggests that the first digital delta is fused with delta *a* of the ball pattern or that it is replaced by it. The ball pattern is a typical *Twin Loop,* like that of the preceding and succeeding Figures, the two loops filling the entire space. This counts in formulation as a *Whorl,* with the exponent letters T. W. Formula: $W^{T.L.}$ 1.

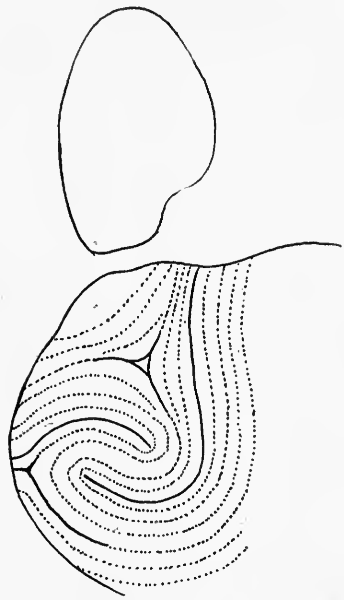


FIGURE 65. Tracing from the print of a left foot, reversed, for better comparison with Figures 41 and 42; natural size. The ball pattern is a modified *Whorl,* the pattern being composed of two interlocking loops, which arise from opposite sides. This is precisely the same as the Twin-Loop composite on the finger bulbs, and may be so named. In formulating, it counts as a W, with an exponent T. L. Formula: $W^{T.L.}$ 1.

Mcs in a directory. That is, if one is looking up a case involving a doubtful type, he may have to look in two separate places before he finds it. As a compensation for this slight hesitation, however, such transition cases are in themselves so unusual that their presence marks with much definiteness the subject possessing them. The exponent system, above explained, furnishes an excellent way of indicating a tendency toward another type; so that such designations, as indicated above, may occasionally be found

useful. In classifying and filing no attention should ever be paid to a descriptive exponent, and the case should be filed under the main letter above.

The first subdivision of sole-prints, then, rests upon the *Form of the Ball Pattern*, and includes the groups W, A, B, C, and O. These

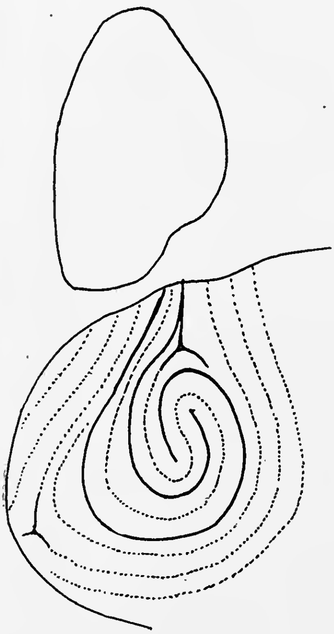


Figure 66. Tracing from the print of a right foot; natural size. The ball pattern is composed of two interlocking loops, which form a figure corresponding exactly to the Lateral Pocket loop of the finger bulbs. This is to be classed as a Whorl, with the exponent letters L.P. Formula: $W^{L.P.}$ 37.

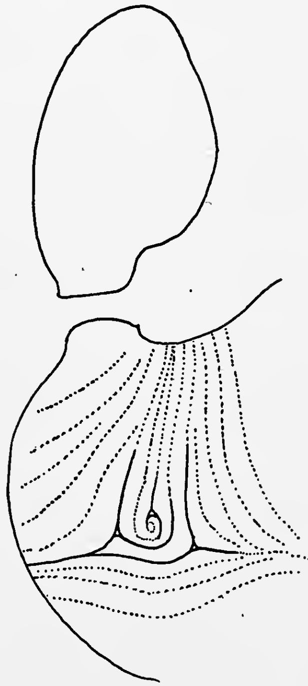


Figure 67. Tracing from the print of a right foot; natural size. The ball pattern has all the appearance of an "A" loop, but the pocket in the center, with the recurving ridges, puts it in the Whorl class, as the variety known as a Central Pocket. In formulating this, it is classed as a Whorl, with the exponent letters C. P. Formula: $W^{C.P.}$ 13.

are quite unequal in occurrence, and in practice subdivisions W and A will be overcrowded, especially the latter. Groups O and B will be small, while C will be hardly represented (one case in some 500 individuals).

To break up these two large groups, W and A, the same expedient may be resorted to as is done in the finger prints (Chapter VI), namely, the *ridge count*. Here, in both A's and W's, the ridges to be counted extend between the core of the pattern and the *b* delta, the one upon the

inner side of the foot. In the case of the A type the delta is fixed at the place where there is a forking of a ridge at the boundary of the pattern on the inside of the foot, one radiant passing upward, the other downward and in a direction as if it were to cross the foot to the outer side, but later curving upward, and forming the outside boundary of the loop, toward the lesser toes. This is the most common form of the delta, but there will be found instances where there is no forking, but instead the wide separation of two adjoining ridges that have been running parallel from the inner side of the foot. Here the first ridge beyond this separation, even though it be but a dot, will be considered the delta. The point of core of the loop will be considered the tip of the central ridge, if there are one or three of them, and the tip of the furthest one from the delta, when there are two. In counting, the core and the delta are excluded, only those ridges being counted which intervene between these two points, and are crossed by an imaginary line between the two. In counting the ridges of whorls, type W, there will be found but little difficulty in making a decision as to the core; in Twin-loops and in Lateral pockets the core furthest from the *b* delta is taken.* (cf. the rules for locating these points in case of finger prints.)

Many hundred prints of both types have been counted, and of these 50 per cent have been found to have a count of less than 26 ridges, and the other 50 per cent, 26 or more. Thus, if we give the sign — to the first and the sign + to the last, the large A and W classes are each divided into two equal groups. There will be cases where the *b* delta will not be printed, as it is often placed a little above the *tread area*, the print made by a simple step, but if a count of 26 or more can be made out, the sign is naturally +. Furthermore a slight pressure with the fingers of the operator when printing will generally bring down into contact with plate and paper a small fold of skin beyond the usual tread area, and thus practically insure the inclusion of this important point, the *b* delta.

Splitting the two largest groups by this means into equal subdivisions we have, for the first classification of soles, *seven* classes, as follows:

W+
W—
A+
A—
B
O

The next procedure, by which each one of these seven groups may be divided still further, deals with the *Three Plantar Areas*, which may be classified in accordance with the patterns they bear.

*Further data concerning the method of counting the ridges, with illustrations of several cases, will be found farther on in this chapter.

As shown above, when the digital deltas are all present in a print, as in Figures 58, 59, and 60, the limits of these three areas may be marked out with considerable precision; in other cases we may be reasonably sure of their boundaries from the presence and arrangements of the patterns, as in Figures 69 and 70. In some cases, too, a lower delta will be found to assist in defining the areas (Figures 60 and 71), yet this must not be too definitely relied upon, as a lower delta may be found to embrace too much, as in Figure 72, or too little, as in Figure 70. Yet, with all these things to guide one, there will always be enough data to allow the recognition and location of a plantar pattern, when present, or to assure one of its absence.

When present, a Plantar pattern may assume one of three forms: it may be (1) a *Loop with the opening at the top like the letter U* (Figure 59, 2); (2) *a Loop with the opening at the bottom*, like an inverted ∩ (Figure 60, 1); (3) *a Whorl*, generally drawn out in an oval (Figure 60, 2.) A fourth condition is, of course, (4) *an area without a pattern* (Figure 59, 1 and 3; Figure 58). By employing for these four conditions the symbols U, ∩, W, and O, respectively, and writing them out in order, a formula is obtained which to a certain extent represents pictorially the condition of the three Plantar areas of a given sole. The usual order from left to right should be always employed in writing out the formula, irrespective of whether the sole is a left or a right one, although the "picture," as such, while dealing with the right foot, will be a reverse of the picture from the left foot. That is, a *print* of the right foot reads naturally from left to right, and corresponds in order with the written formula; a *print* of the left foot reads from right to left, but its formula is written from left to right, as is usual.

To familiarize himself with the determination of the conditions of the three Plantar areas, and with this method of formulating them, the reader is advised to study the various tracings of soles given in this chapter, and at the same time follow through the descriptions and formulations here given.

Figure 58. Here, with the four digital deltas present, it is an easy matter to separate the three Plantar areas. No one of them has a pattern and the formula is O O O.

Figure 59. Here, also, the digital deltas, aided by a lower delta, definitely mark out the areas. The second alone bears a pattern, and the formula is O U O.

Figure 60. Owing to fusions in the digital areas at the base of the toes the precise limits of the Plantar areas are not easy to mark. This makes no difference, however, in the pattern formulation, as the general regions are obvious enough. All bear patterns, the formula being ∩ W U.

Figure 63. In this print the digital deltas, which may always be

relied upon when present, definitely mark off the three Plantar areas. The lower delta here furnishes a radiant which, uniting with the one proceeding from the first digital delta, clearly separates the ball area from the first Plantar, but otherwise the radiants embrace the entire Plantar region and are useless for our purpose. Area 2 alone possesses a pattern, and the formula runs O U O.

Figure 64. Here the areas are well marked and all patternless. In such a case, where the absence of all pattern cores on the Plantar region

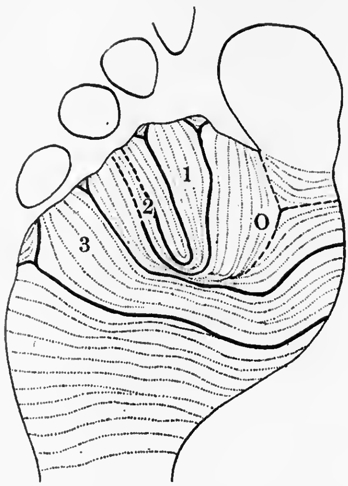


FIGURE 68. Tracing from the sole print of a left foot. The four digital deltas are all present. Their radiants recurve, but there is no lower delta. The ball pattern is wanting. Formula: O 5.

is so obvious, a division into the three areas is not necessary, and the formula may be written at a glance as O O O. The invasion of Plantar area 1 into the Ball pattern is unique.

Figure 68. The narrow loop shown in area 2 is plainly the remnant of a U-shaped pattern belonging to that area. Formula, O U O.

Figure 69. In this sole the pattern belonging to area 2 has become so broad that it has all but pressed out of existence the minute rudiment of the third area. This last shows by the converging lines the last traces of a pattern, but, *as there are no ridges that actually recurve*, there is technically no pattern there. This reduces the formula to the very common one, O U O, although, if desired, the rudiment of the third pattern may be expressed by a small exponent letter r, placed to the right of, and a little

above the last O. This is for description only, and should in no way be considered in classification.

Figure 70. This figure shows plainly the unreliability of a lower delta, which here fails to include the entire second area. Yet, although this is evidently the case, and although the pattern core is small and pushed far towards the outer side, there can be no doubt that it is Pattern 2. Formula, O U O.

Figure 71. This is like the preceding, but with the lower delta open sufficiently to include the entire second area. The lower radiant of this

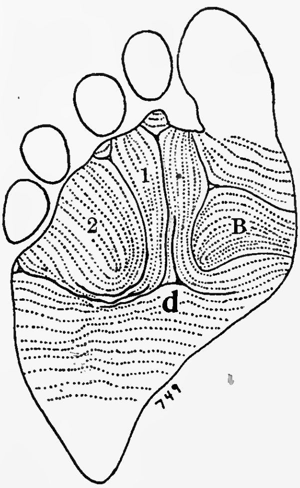


FIGURE 69. Tracing from a print of a left sole. The ball pattern is a typical B loop, opening to the inner margin. The second and third plantar areas are closely associated, without definite boundaries between them, but the disposition of the ridges suggests that the second pattern has become so large that it has almost suppressed the third area. This latter still shows the vestiges of a pattern, yet cannot be counted, as it has no recurving ridges. Formula: B 5d.

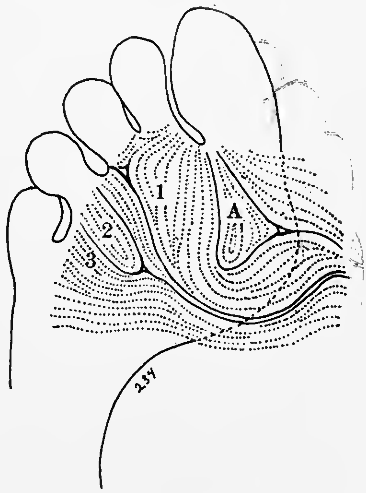


FIGURE 70. Tracing from the print of a left sole. The lower delta embraces only a part of the second plantar area. Formula: A 5d.

lower triradius comes down in such a way as to separate the parallel ridges of areas 1 and 3, which come into contact below the second area. The ridges of area 1 become included within the Ball area, but those of 3 do not. Formula, O U O.

Figure 72. In this curious sole, areas 1 and 2 are included within the two upper radiants of the lower delta, area 2 showing the effect of

crowding. Technically its pattern is obliterated, as there are no recurving lines, but its place is indicated by the converging ridges. This may be marked in the formula by an r, if desired. Formula, U O O.

Figure 73. A sole with the common formula O U O, and with a large lower delta, the upper radiants of which include the entire Plantar region.

Although by no means equally common, the possible combinations of terms in the pattern formula of soles is 64, as shown by the table below.

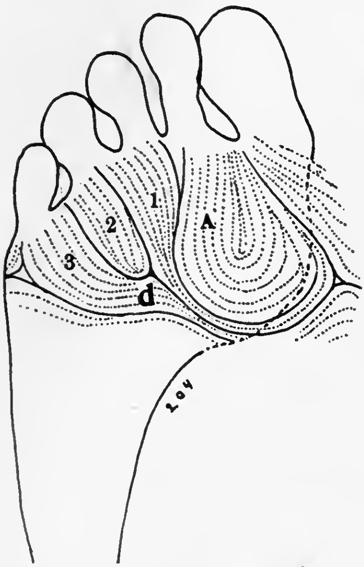


FIGURE 71. Tracing from the print of a left sole. This is similar to the previous one, but with the lower delta embracing more of the second area, perhaps all of it. Formula: A 5d.

FIGURE 72. Tracing from the print of a left sole. Here areas 1 and 2 are practically fused, but the ridges indicate clearly that the loop, which forms the single pattern here, belongs to 1. Formula: W 21d.

If one is in possession of this table, he may materially shorten a sole formula by using, instead of the three characters, the number here affixed. Thus, instead of writing out in full the formula W U O, use the number 57; or, conversely, if a sole formula reading A9 is received, it will mean that the sole in question has a Ball pattern consisting of a loop opening upward, followed by a Plantar area with but one pattern, and that one an inverted loop upon the second area. Thus, by means of a single capital letter followed by a single figure the details of a certain special sole print are given with so much detail that the main features of a rather compli-

cated arrangement could be sketched with pencil and paper, corresponding, except in proportions, to the sole in question.

PROPOSED NUMERICAL TABLE FOR THE SHORTHAND FORMULATION OF THE CONDITIONS FOUND ON THE PLANTAR AREAS OF THE SOLE

O. O. O. 1.	U. O. O. 17.	∩. O. O. 33.	W. O. O. 49.
O. O. U. 2.	U. O. U. 18.	∩. O. U. 34.	W. O. U. 50.
O. O. ∩. 3.	U. O. ∩. 19.	∩. O. ∩. 35.	W. O. ∩. 51.
O. O. W. 4.	U. O. W. 20.	∩. O. W. 36.	W. O. W. 52.
O. U. O. 5.	U. U. O. 21.	∩. U. O. 37.	W. U. O. 53.
O. U. U. 6.	U. U. U. 22.	∩. U. U. 38.	W. U. U. 54.
O. U. ∩. 7.	U. U. ∩. 23.	∩. U. ∩. 39.	W. U. ∩. 55.
O. U. W. 8.	U. U. W. 24.	∩. U. W. 40.	W. U. W. 56.
O. ∩. O. 9.	U. ∩. O. 25.	∩. ∩. O. 41.	W. ∩. O. 57.
O. ∩. U. 10.	U. ∩. U. 26.	∩. ∩. U. 42.	W. ∩. U. 58.
O. ∩. ∩. 11.	U. ∩. ∩. 27.	∩. ∩. ∩. 43.	W. ∩. ∩. 59.
O. ∩. W. 12.	U. ∩. W. 28.	∩. ∩. W. 44.	W. ∩. W. 60.
O. W. O. 13.	U. W. O. 29.	∩. W. O. 45.	W. W. O. 61.
O. W. U. 14.	U. W. U. 30.	∩. W. U. 46.	W. W. U. 62.
O. W. ∩. 15.	U. W. ∩. 31.	∩. W. ∩. 47.	W. W. ∩. 63.
O. W. W. 16.	U. W. W. 32.	∩. W. W. 48.	W. W. W. 64.

A third further step in classifying sole prints is found in the *presence or absence of lower deltas, and the number of them that occur.* Attention has already been called to these, and their occasional assistance in determining the limits of a plantar area. They are seen singly, in all sorts of relationships to the other parts, in Figures 59, 63, 69, 70, 71, 72, and 73, while two are seen in Figure 60. Rarely three are found, but never more, leading to the suspicion that originally, *i.e.* in the typical form, there was one of these at the base of each of the three Plantar areas, serving as one of its typical three deltas. This original relation is suggested by Figure 60. In the same way a single one may sometimes be considered

the result of the fusion of two of the original ones, notably in such cases as Figure 72, where the radiants embrace two patterns.

For practical formulation, and leaving aside all these theories in the present case, we simply note the presence of these lower deltas, indicating them, when present, by the letter *d*, added to the pattern formula, a letter for each delta present. Thus the complete formulation of a sole consists of three parts: (1) the letter indicating the Ball pattern, (2) the formula for the three Plantar Areas (or its abbreviation), and (3) the Lower Deltas.

Written out completely, the soles here illustrated are formulated as follows:*

Figure	Formula written in full	Formula abbreviated
58	A O O O	A 1
59	W O U O d	W 5 d
60	W ∩ W U dd	W 46 dd
63	W O U O d	W 5 d
64	W O O O	W 1
68	O O U O	O 5
69	B O U O d	B 5 d
70	A O U O d	A 5 d
71	A O U O d	A 5 d
72	W U O O d	W 17 d
73	A O U O d	A 5 d

We have thus, in the formulæ presented in the middle column, and, by the help of a table equally clearly expressed in the right-hand column, a simple method for recording in the briefest possible form the main characteristics of a sole. This does not take into account any of the details of the separate ridges, but serves merely to divide a large collection into small subdivisions for easy reference. Let us now see how such formulæ may be classified and placed in compartments.

To begin with, we have the character for the Ball pattern, which falls into seven distinct classes. If these are placed in the natural alphabetical order, and if a + sign precede a —, they should be arranged as:

A+
A—
B
C
O
W+
W—

Those coming under each one of these seven classes may be next arranged according to the formulæ for the Plantar formulæ, following the

*The distinctions of + and —, recommended for subdividing the A's and the W's are not used here.

order of the table given above, in 64 subdivisions. If these occur under each of the seven primary classes, we now have 7 x 64, or 448. Each of these 448 subdivisions may be still farther subdivided by the characters of the lower delta, whether *one*, *two*, *three*, or *none*, four subdivisions, making 448 x 4, or 1,792 separate groups.

Now in the absence of sufficient data, it is as yet impossible to say whether in actual occurrence these 1,792 groups are anywhere near equally represented in the human race, and whether perhaps certain ones, like A5, and W1, may contain an overwhelming majority, while others may never actually occur. Only a long practical trial will decide this point, but we can rest assured that, in the infinity of individual variations of which so complicated a configuration as that of the sole is capable, it will be an extremely simple matter so to modify the details of classification that it will prove perfectly satisfactory.

Thus far we have spoken of the use of a single foot, formulating and classifying it by itself. The use of both feet will greatly multiply the subdivisions, since, although the examination of many hundred sole prints has shown that the two feet have the same formula in very many cases, so also there have been found many cases, rather more than the first, in which there are marked differences in the two. The Ball pattern may belong to distinct types; the formula for the three Plantar patterns may vary greatly; or often, when otherwise the soles are similar, a lower delta may be present on one side and not on the other. If the two sides of the same individual were quite independent of each other, and as likely to differ as two rights or two lefts of different, unrelated human beings, then the number of possible compartments into which a large collection of sole prints could be divided (put in pairs) would naturally be the square of the number calculated above; 1,792 = 3,204,264, which would take a very large office to provide for; but, with the large amount of similarity between the two, the number, though large, would not be nearly so large as this.

Suppose that we wish to arrange a collection of sole prints, taken in pairs, with the formulæ written in the form of a common fraction, with the right foot above and the left below. With the A and W both divided by the + and — signs, as we propose, there are *forty-nine* possible classes for primary subdivision, that is, subdivisions based upon the character of the Ball pattern only. These are shown, in tabular form, upon the next page.

That is, worked out on paper there are actually 49 possible classes into which to put the formulæ of the soles, grouped in pairs, but that is unfortunately a long way from asserting either that all of the 49 will be about equally populous, or even that all the types will actually occur at all. Since, for instance, Type C is extremely rare, all the groups into which a C is introduced, 13 of them, are practically non-existent, which

at once reduces the available groups from 49 to 36. Again, owing to the tendency for the two soles to resemble each other, it is altogether probable that such groups as $\frac{A+}{A+}$, $\frac{B}{B}$, or $\frac{W}{W}$ will be much fuller than many of the others.

$\frac{\text{Right}}{\text{Left}}$	$\frac{A+}{A+}$	$\frac{A+}{A-}$	$\frac{A+}{B}$	$\frac{A+}{C}$	$\frac{A+}{O}$	$\frac{A+}{W+}$	$\frac{A+}{W-}$
$\frac{\text{Right}}{\text{Left}}$	$\frac{A-}{A+}$	$\frac{A-}{A-}$	$\frac{A-}{B}$	$\frac{A-}{C}$	$\frac{A-}{O}$	$\frac{A-}{W+}$	$\frac{A-}{W-}$
$\frac{\text{Right}}{\text{Left}}$	$\frac{B}{A+}$	$\frac{B}{A-}$	$\frac{B}{B}$	$\frac{B}{C}$	$\frac{B}{O}$	$\frac{B}{W+}$	$\frac{B}{W-}$
$\frac{\text{Right}}{\text{Left}}$	$\frac{C}{A+}$	$\frac{C}{A-}$	$\frac{C}{B}$	$\frac{C}{C}$	$\frac{C}{O}$	$\frac{C}{W+}$	$\frac{C}{W-}$
$\frac{\text{Right}}{\text{Left}}$	$\frac{O}{A+}$	$\frac{O}{A-}$	$\frac{O}{B}$	$\frac{O}{C}$	$\frac{O}{O}$	$\frac{O}{W+}$	$\frac{O}{W-}$
$\frac{\text{Right}}{\text{Left}}$	$\frac{W+}{A+}$	$\frac{W+}{A-}$	$\frac{W+}{B}$	$\frac{W+}{C}$	$\frac{W+}{O}$	$\frac{W+}{W+}$	$\frac{W+}{W-}$
$\frac{\text{Right}}{\text{Left}}$	$\frac{W-}{A+}$	$\frac{W-}{A-}$	$\frac{W-}{B}$	$\frac{W-}{C}$	$\frac{W-}{O}$	$\frac{W-}{W+}$	$\frac{W-}{W-}$

The Plantar patterns, with 64 variations for each sole, would, if the soles were independently variable, furnish 64 classes, or 4,096, and if each of the 49 classes based upon the Ball patterns were again subdivided, the number of possible classes would be 49 x 4,096, or 200,704.

Lastly the occurrence of lower deltas admits, in the two feet, the following separate classes, *d* standing for the occurrence of such a delta, *o* for the absence, and repeating the *d* for each delta:

$$\frac{d}{d} \quad \frac{d}{dd} \quad \frac{d}{ddd} \quad \frac{d}{o} \quad \frac{dd}{d} \quad \frac{dd}{dd} \quad \frac{dd}{ddd} \quad \frac{dd}{o}$$

$$\frac{ddd}{d} \quad \frac{ddd}{dd} \quad \frac{ddd}{ddd} \quad \frac{ddd}{o} \quad \frac{o}{d} \quad \frac{o}{dd} \quad \frac{o}{ddd} \quad \frac{o}{o}$$

With all possible classes used, we would now have the very large number of separate subdivisions represented by 49 x 64 x 16, or 3,211,264, *i.e.* over 3,200,000. This number is surely large enough to allow considerable reduction of the theoretical figures, to allow for non-occurrence of certain combinations, and still be large enough for any practical test that could be applied.

Although many hundreds, or even thousands, of sole prints must be taken and formulated before the actual occurrence of these groups can become known, we may begin the investigating by presenting here, in the

form of a table, the complete sole formulæ, rights and lefts in pairs, of 100 young women, collected in the Anthropological laboratory of Smith

SOLE FORMULÆ OF 100 WOMEN STUDENTS FROM SMITH COLLEGE, REPRESENTING ALL PARTS OF THE UNITED STATES, AND INCLUDING MANY ORIGINAL EUROPEAN RACES AND NATIONALITIES.

Left	Right	Both	Left	Right	Both	Left	Right	Both	Left	Right	Both
A 5 d	A 5 d	A 5 d / A 5 d	W 59 d	W15 d	W 15 d / W 59 d	W 37 d	A 5 d	A 5 d / W 37 d	A 5 d	A 1	A 1 / A 5 d
A 5 d	A 5 d	A 5 d / A 5 d	C 53 d	W 45 d	W 45 d / C 53 d	A 1	A 1	A 1 / A 1	A 37 d	A 37 d	A 37 d / A 37 d
A 5 d	W 5 d	W 5 d / A 5 d	W38dd	W 37 d	W 37 d / W38dd	W 1	W 9 d	W 9 d / W 1	O 29 d	O 15	O 15 / O 29 d
W 1	A 33	A 33 / W 1	W 37 d	W 38 d	W 38 d / W 37 d	A 5 d	A 6 dd	A 6 dd / A 5 d	A 1	A 5 d	A 5 d / A 1
W 1	A 1	A 1 / W 1	A 1	A 1	A 1 / A 1	W 13 d	B 9	B 9 / W 13 d	W 13 d	W 13 d	W13 d / W 13 d
A 5 d	B 1	B 1 / A 5 d	W 1	W 1	W 1 / W 1	A 5 d	A 5 d	A 5 d / A 5 d	A 45 d	A 45 d	A 45 d / A 45 d
W 1	W 1	W 1 / W 1	A 5 d	A 5 d	A 5 d / A 5 d	W 1	W 1	W 1 / W 1	O 5 d	O 14 d	O 14 d / O 5 d
A 5 d	A 37 d	A 37 d / A 5 d	A 1	A 1	A 1 / A 1	A 1	A 1	A 1 / A 1	A 2 d	A 2 d	A 2 d / A 2 d
A 5 d	A 21 dd	A 21 dd / A 5 d	A 1	A 1	A 1 / A 1	A 37 d	A 37 d	A 37 d / A 37 d	A 1	A 5 d	A 5 d / A 1
B 42 d	B 2 d	B 2 d / B 42 d	W 1	W 5 d	W 5 d / W 1	B 1	B 33	B 33 / B 1	B 13 d	W 13	W 13 / B 13 d
W 49 d	W 49 d	W 49 d / W 49 d	A 5 d	A 5 d	A 5 d / A 5 d	A 37 d	A 37 d	A 37 d / A 37 d	A 1	A 1	A 1 / A 1
W 1	W 1	W 1 / W 1	W 1	A 1	A 1 / W 1	O 1	A 1	A 1 / O 1	W 13 d	W 45 d	W 45d / W 13 d
A 1	A 1	A 1 / A 1	A 6 dd	A 6 dd	A 6 dd / A 6 dd	O 38 d	A 38 d	A 38 d / O 38 d	A 5 d	A 5 d	A 5 d / A 5 d

Left	Right	Both	Left	Right	Both	Left	Right	Both	Left	Right	Both
W 1	W 1	W 1 W 1	A 1	A 1	A 1 A 1	A 1	A 1	A 1 A 1	A 6ddd	A 6 d	A 6 d A 6 ddd
W 9	W 37 d	W 37 d W 9	A 5 d	A 2 d	A 2 d A 5 d	B 41	A 13 d	A 13 d B 41	A 1	A 1	A 1 A 1
A 9	A 25 d	A 25 d A 9	A 5 d	A 5 d	A 5 d A 5 d	W 1	A 1 d	A 1 d W 1	A 1	A 1	A 1 A 1
A 1	W 1	W 1 A 1	A 5 d	A 6 d	A 6 d A 5 d	A 1	A 1	A 1 A 1	A 37 d	A 5 d	A 5 d A 37 d
W 1	A 2 d	A 2 d W 1	A 33	A 5 d	A 5 d A 33	B 13 d	A 13 d	A 13 d B 13 d	B 5 d	W 5 d	W 5 d B 5 d
W38dd	W 6 dd	W 6 dd W38dd	A 13 d	A 41 d	A 41 d A13 d	A 1	A 2 d	A 2 d A 1	W 5 d	A 5 d	A 5 d W 5 d
W 37 d	W 38 d	W 38 d W 37 d	A 1	A 33	A 33 A 1	W 49d	W53dd	W53dd W 49 d	O 2 d	O 19	O 19 O 2 d
A 5 d	A 5 d	A 5 d A 5 d	W 9	W 9	W 9 W 9	W 1	W 33	W 33 W 1	A 5 d	A 5 d	A 5 d A 5 d
B 41	B 9	B 9 B 41	A 5 d	A 5 d	A 5 d A 5 d	W 1	W 1	W 1 W 1	W 5 d	W21dd	W 21 dd W 5 d
A 5 d	A 5 d	A 5 d A 5 d	A 6 dd	A 46dd	A 46dd A 6 dd	B 5 d	B 5 d	B 5 d B 5 d	A 1	A 1	A 1 A 1
A 33	W 1	W 1 A 33	W 1 d	A 17 d	A 17 d W 1 d	W 13 d	A 13 d	A 13 d W 13 d	B 5 d	W 5 d	W 5 d B 5 d
W38dd	W14dd	W14dd W38dd	W 5 d	A 1	A 1 W 5 d	W 1	A 1	A 1 W 1	W 5 d	W 5 d	W 5 d W 5 d

College, and representing in their ancestry all parts of Europe. This is the first attempt at a practical application of the system here advocated, and although 100 is a sadly inadequate number to draw conclusions from, the system may be seen here in actual use. No attempt is made in this table to arrange these formulæ, and they are recorded just as they happened to be collected. The subdivision of the A's and W's by the signs + and — is also not made.

If we now arrange these 200 separate formulæ as if they were actually to be placed in a filing cabinet, using them as separate soles, without grouping into pairs, we get the results expressed in the table next presented. The capital letters representing the condition of the Ball patterns naturally succeed one another in alphabetical order, A, B, C, O, W; the lower deltas, in accordance with the number present. We begin with a complete *absence*, followed by *one*, *two*, and *three*; *d*, *dd*, *ddd*.

In this table the figures indicate the times of occurrence of each formula in the two sides separately. The total occurrence of any of the formulæ represented is obtained by adding together the two numbers given for the separate sides.

TABLE SHOWING THE OCCURRENCE OF SPECIFIC FORMULAE IN THE FEET OF THE 100 INDIVIDUALS OF THE PRECEDING TABLE

Formula	L	R	Formula	L	R	Formula	L	R	Formula	L	R
A 1	18	19	A 38d	0	1	O 5d	1	0	W 13d	4	1
A 1d	0	1	A 45d	1	1	O 14d	0	1	W 14dd	0	1
A 2d	1	4	A 46dd	0	1	O 15	0	1	W 15d	0	1
A 5d	19	17	B 1	1	1	O 19	0	1	W 21dd	0	1
A 6dd	2	3	B 2d	0	1	O 29d	1	0	W 33	0	1
A 6ddd	1	0	B 5d	3	1	O 38d	1	0	W 37d	3	2
A 9	1	0	B 9	0	2	W 1	15	8	W 38d	0	1
A 13d	1	3	B 13d	2	0	W 1d	1	0	W 38dd	3	1
A 21dd	0	1	B 41	2	0	W 5d	4	5	W 45d	0	2
A 17d	0	1	B 42d	1	0	W 6d	0	1	W 49d	2	1
A 25d	0	1	B 33	0	1	W 6dd	0	1	W 53dd	0	1
A 41d	0	1	C 53d	1	0	W 9	2	1	W 60d	1	0
A 33	2	2	O 1	1	0	W 9d	0	1			
A 37d	4	4	O 2d	1	0	W 13	0	1			

From this it will be seen that there are in all 54 different formulæ represented; that 12 occur in the left soles alone, 24 in the rights alone, while 16 are common to both. No less than 33 are found but once in the

200, but, on the other hand, there are 9 that occur five times or more each. These, the commonest and consequently the first to need further subdivision, are the following:

A	1		= 37	cases
A	5	d	= 36	cases
W	1		= 23	cases
W	5	d	= 9	cases
A	37	d	= 8	cases
W	37	d	= 5	cases
W	13	d	= 5	cases
A	2	d	= 5	cases
A	6	dd	= 5	cases

As the total number of formulæ considered is 200, the *percentage of occurrence* of each of these is exactly one half of the number here given. Thus the first of these common formulæ will have a percentage of 18.5 per cent; the second, 18.0 per cent; the third, 11.5 per cent, and so on.

From the same table the percentage of occurrence of the different Ball patterns may also be made out. Pattern A (undivided by + and —) occurs in 110 of the formulæ, that is, 55 per cent; Pattern W, the next in frequency, in 66 cases, or 33 per cent; Pattern B, the next, appears in 15 cases, or 7.5 per cent; and Pattern O in 8 cases, or 4.0 per cent. Pattern C, the rarest, occurs but once, or .5 per cent.

Since the more constant and reliable patterns occur along the large distal cushion of the foot, commonly termed the "ball," any system of formulation and classification must rest largely upon this portion, and ignore the remainder, extending through the hollow of the arch, and terminating in the heel. However, although this latter extensive area is usually without special features, and covered by approximately parallel ridges that run transversely across the foot, there are in this region occasional patterns, more or less rare in their occurrence, which, when they happen to be present, should not be overlooked.

The first, and commoner, of these, the *Fibular*, or *Outer pattern*, consists of a loop, placed with its convex, closed, end, toward the outer edge, and opening inward toward the main part of the sole, and the side of the great toe. It is usually a rather small, narrow loop, placed not far from the base of the toes, below the Plantar Areas (Figure 73). Occasionally it is double, with a delta between the two, and in either its single or double condition it may be broad enough to cover the entire middle of the foot, from ball to heel. Once in a while the core of the loop, and perhaps a little more, may lie within the tread area, and form a conspicuous feature of an ordinary tread area print; or, again, the core may lie just beyond it, so that the rounded ridges that form the loop are not seen. In this latter case the core may be printed by rolling the foot outward. This pattern

corresponds to the "*Outer*," or *Ulnar pattern* of the palm, and is named the *Fibular pattern,* from the outer of the two bones of the lower leg, the *fibula,* which in position corresponds to the *ulna* of the forearm.

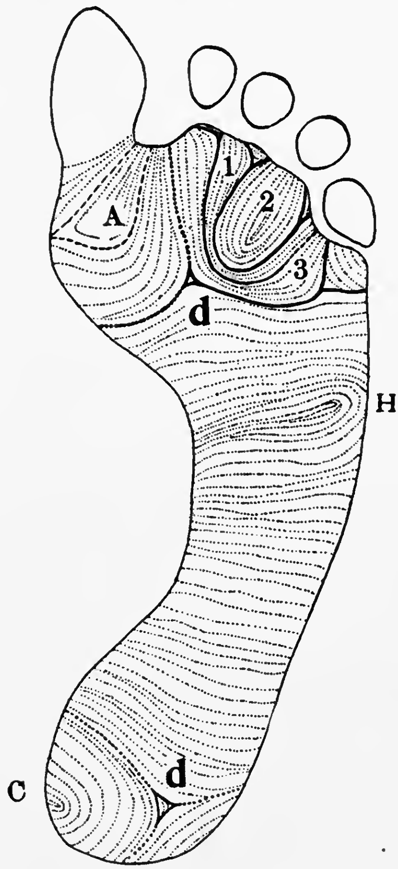


FIGURE 73. Tracing of the entire sole print of a small boy, showing both the hypothenar (fibular) loop (H), and the rare calcar pattern (C). This latter is always associated with a triradius of its own (d).

The second of the occasional features is the *Calcar pattern* (Figure 73, C). As its name denotes, it occurs upon the heel, and is usually in the form of a simple loop, opening inward and somewhat forward, and accompanied by a distinct delta. The present authors know of but nine cases of this rarest of patterns in some 800 separate feet, and as in two cases the individuals so marked possessed this feature on both heels, this reduces the number of

different individuals thus marked to seven. Of these, again, five were members of one family, where the pattern was undoubtedly inherited. Two further cases have been cited by European investigators, thus making only eleven separate patterns thus far known.

It is plain that an individual having a Calcar pattern is a marked man, whose footprints could be identified almost at a glance. Such being the case, it is recommended that all such be filed in a division by themselves, irrespective of their formulæ otherwise. Their prints will not take up much room, even in a large collection, and this separation will be extremely convenient if a question ever comes up concerning the identity of an individual so marked.

The authors in concluding this chapter wish to call attention to one slight difficulty, a mechanical one, easily overcome; the *inner delta* ("B" delta), on the inside edge of the foot, is frequently placed over the edge of the tread area, and needs a slight rolling inward of the foot, when being printed, in order to get it in the print. This rolling in is, however, a very simple motion, and can be easily accomplished if the subject, just before lifting his foot from the inked surface, and again from the paper, give the foot a slight inward roll, enough to extend the printed area about a half-inch.

CHAPTER V

FINGER PRINTS; DESCRIPTION AND CLASSIFICATION

"*Dactyloscopy, or the proving of identity by the digital patterns, consists of studying the patterns found upon the tips of the digits. There is no more difference between the digital designs of a child who is just born, and those of the same subject at two years, five years, ten years, twenty years, than there is between successive enlargements of the same photographic negative. The physiological wear of the skin, or, in other words, the age, does not change in the least detail the design, which is not modified, either pathologically, or by the will of the subject. In fact, even burns, whether due to hot metal, hot oil, or boiling water, merely raise a blister which, after bursting, leaves a place for new skin. One cannot distinguish the imprints taken before and after the burn. The finger patterns are never identical in two subjects, for if two individuals could show the same design, the matter would lose all practical interest. Finally, the designs formed by the papillary ridges (in particular those of the finger tips) have the triple characteristics of perpetuity, immutability, and variety; they remain the same during the life of the subject, who cannot change them. Certainly not a single judicial error can be cited which may be imputed to them.*" — *M. Edmond Locard, Director of the Police Laboratory of Lyons, France. 1914.*

DACTYLOSCOPY* or the examination of the finger patterns to prove identity, although now in such general use, may be almost considered a product of the twentieth century, as its introduction through the labors of Sir Francis Galton, precedes the year 1900, by only about five years.

The framework of a finger consists of three bones, the *phalanges*, which form hinge joints where they come together. The *basal*, or *proximal*, phalange† is the one nearest the palm, at the base of the finger, followed

* The term *Dactyloscopy*, now so widely used in European countries, is formed of two Greek words, *dactylos*, a finger, and *skopein*, to examine, and means literally: *an examination of the fingers*. Constructed in the same way we may have *Poroscopy* (*poros*, a pore), the examination of the pores, and *Chiroscopy* (*cheir*, a hand), the examination of the hands; *i. e.*, the palms. If ever needed there could be formed the word *Podoscopy* (*podo*, foot), to signify the study of the soles.

† In technical anatomical language the Greek form of the singular is used, *Phalanx*, and the three are called in order, beginning with the one nearest the wrist, *proximal phalanx, middle phalanx, terminal phalanx*. In English the proper singular form would be *phalange*, and is used here (compare syrinx, syringe).

in turn, proceeding toward the tip, by the *middle phalange*, and *end* or *terminal phalange*. The French have a separate word for each, and call them, in the same order, *phalange*, *phalangine*, *phalangette*.* As this use is extremely convenient, and as the words themselves are not out of harmony with the English language, it would be well for us to adopt this sensible nomenclature.

The thumb has only basal and terminal phalanges, phalange and phalangette, omitting the middle one, the phalangine. The toes cor-

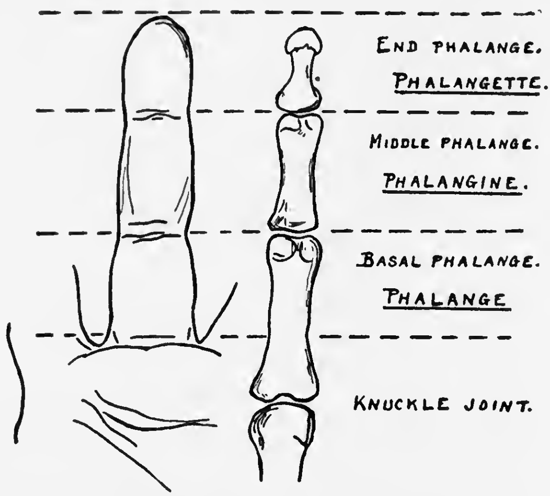


FIGURE 74. Left middle finger, and the bones of the same, both seen from the lower, or palmar aspect. It will be seen that the bone of the basal phalange extends down into the palm, and that the base of the free finger, at the level of the notches between the fingers, comes just below the middle of the bone.

respond exactly to the fingers in the number and arrangement of their phalanges, two in the first, or "great" toe, and three each in the others, in all fourteen in an entire foot or hand.

The lower, or palmar, surfaces of all the phalanges are covered with friction-skin, bearing ridges, but it is only upon the prominent cushions of the terminal phalanges, the "finger-balls," that they arrange themselves into definite patterns. Elsewhere the ridges run in somewhat irregular course, with a tendency to either slant or curve; and thus, while in the

* Although properly speaking, the terms *phalange* (or *phalanx*) *phalangine*, and *phalangette*, were applied originally to the bones, it is convenient to use them also for the corresponding length of the fingers when clothed in flesh. In what follows they will be so used.

case of chance impressions, any of the phalanges may prove of the utmost importance, it is to the finger balls of the end phalanges that our attention is especially directed. These are the "Finger Prints" of ordinary parlance, and thus far have occupied the main attention of the experts.

FIGURE 75. Print of the left middle finger of William B ——, rolled the entire length. The subject is a hard-working farmer, and the ridges are correspondingly heavy and distinct. The harder the usage, the stronger and firmer the ridges. Pattern: Ulnar Loop of 13 ridges. Code word, UNCOVER.

The Types of Patterns. In 1823 Purkinje made a careful study of the finger patterns, and grouped them in *nine* groups, or types, to each of which he affixed a definite name; the *oblique loop*, the *spiral*, the *double whorl*, the *almond*, and so on. Galton, writing in the 80's, made a much simpler

grouping of the types, and embraced them all under *three*, the *Arch*, the the *Loop*, and the *Whorl*. These he designated by their initial letters, and upon them he founded his now famous ALW classification. This was the foundation of the present classification, which differs mainly in the recognition of a *fourth* class, that of the *Composites*, introduced for

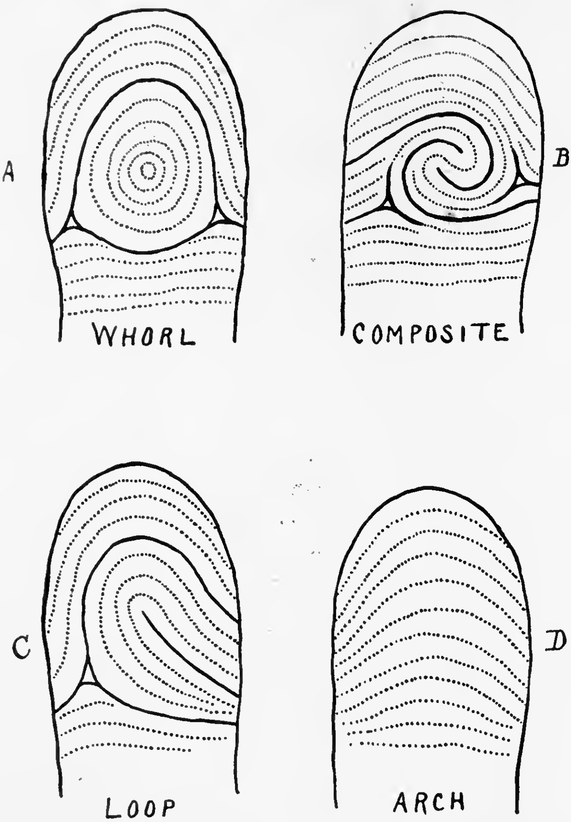


FIGURE 76. Diagrams of the four main types of finger patterns. The whorl and composite have *two* deltas; the loop *one*, and the arch *none*.

practical purposes by Sir E. R. Henry, and intended to include all forms of patterns not readily included under either *arches*, *loops*, or *whorls*. To this class would be referred patterns with two loops, loops with pockets, various sorts of spirals, and all forms of eccentrics. The classification of finger prints is rendered so simple by this means that with a little patience any one may soon be able to distinguish these four classes at sight.

Two further points are, however, to be noted:

1. There are two kinds of loops, *Ulnar* and *Radial*. The Ulnar type, which is much the commoner, opens toward the outer, or ulnar side, of the hand,— the side of the little finger; the Radial type opens toward the inner, or Radial, side — the one toward the thumb.*

2. Aside from the usual form of arch, where the ridges run in curves across the finger, there is a modification known as the Tented Arch, where the curve becomes a sharp one, and the ridge in the center, or *core*, runs lengthwise like the pole of a narrow A-tent, causing the ridges on the sides to run over it in the form of a sharp angle.

By using the following abbreviations, the patterns of a given hand may be readily expressed in the form of a simple formula, after a few minutes' examination: A = Arch; T = Tented Arch; R = Radial Loop; U = Ulnar Loop; W = Whorl; C = Composite. There are also certain definite types of Composites, like the Central Pocket Loop (C. P.), the Twin Loop (T. L.), etc., which are taken up below, and have also their own abbreviations. Their use makes this simple pattern formula a more precise one, but these need not be taken up here.

Using the above abbreviations the formulæ for a series of hands, when written out, would appear like the following:

W — R — U — W — U
A — R — W — W — R
W — T — U — U — U

In all such formulæ, whether for the right or the left hand, the abbreviation for the thumb is placed at the left, followed by that for the index, middle, etc., in the natural order. In a print of an entire hand, or of the fingers together, this order corresponds exactly to the patterns of the right hand, but is the opposite of the order shown in the left; in actual hands, where the order is the reverse of a print, it is the left hand whose fingers are presented as written, while the right hand is reversed. The reader will see this in a moment by holding up his own left hand and comparing it with a print. The hand corresponds to the order of the above formulæ, thumb on the left, and so on; the print reverses it

Explained in another way, the order of fingers on the actual hands, held before one, Palmar side up, is:

1 — 2 — 3 — 4 — 5 | 5 — 4 — 3 — 2 — 1

*There are two bones in the forearm: *Ulna* and *Radius*. The Ulna lies along the outside, corresponding to the little finger side of the hand. Its upper end forms the elbow, and the arm naturally rests on the ulna when placed on the table, in contact with it from elbow to hand. The Radius is the inner of the two, and comes down to the thumb-side of the hand. The two sides of the hand are thus conveniently termed *ulnar* and *radial*, the little-finger side and the thumb-side respectively.

and the order found in a print, which naturally reverses the picture, is:

5 — 4 — 3 — 2 — 1 | 1 — 2 — 3 — 4 — 5

while it is to be remembered *that in all formula writing the order is invariably the most natural one*, 1 – 2 – 3 – 4 – 5.

If the two hands are to be written out together *they are placed in the form of a fraction, with the right hand invariably above the line, in the place of the numerator, and the left hand below the line, in the place of the denominator*, as follows:

$$\begin{array}{ll} \text{Right hand:} & \dfrac{1 - 2 - 3 - 4 - 5}{1 - 2 - 3 - 4 - 5} \\ \text{Left hand:} & \end{array}$$

This formula, in a given case, would appear thus:

$$\frac{\mathrm{W - R - U - W - U}}{\mathrm{A - R - W - W - R}}$$

In practice we have found it convenient, in writing out such formulæ, to employ an oblique line,/, to designate Loops, the two kinds, Ulnar and Radial, being represented by the two slopes, / and \\. *These should correspond to the slopes as seen in the prints, not in the hands*, which would give the following usage:

Right Ulnar	\
Right Radial	/
Left Ulnar	/
Left Radial	\

This shows in the formula as a conventionalized picture of the pattern, and appears as follows, using the same formula as the last:

W — / — \ — W \
A — \ — W — W \

In this example it will be noted that the Loops of the left hand are both Radial, while the Loops of the right middle and little, although indicated by diagonal lines that slope the same way, are here Ulnar Loops.

The following formulæ, written out in the more usual way, are taken haphazard from different individuals, as illustrations of this simple method of describing a man by his finger patterns, although in actual practice somewhat more complicated methods are in general use.

(1) W — T — U — U — U (H. H. W.)
U — T — U — U — U

(2) U — T — U — U — U (B. W.)
U — U — U — U — U

(3) C — W — U — U — U (I. W. W.)
C — U — U — U — U –

(4) A — A — U — U — A (E. J. W.)
A — A — U — U — A

(5) U — A — U — U — U (R. E. P.)
A — U — U — U — U

(6) U — A — U — U — U (B. B.)
U — A — U — U — A

(7) W — W — W — W — U (J. C.)
W — W — W — W — U

(8) U — R — W — W — U (J. N.)
W — W — R — W — U

These actual cases, taken at random, do not show a great variety of patterns, but they represent what one has to deal with in actual work. The first two are those of the two authors of this book, the next two are their wives, the next is a little girl, and the last three are criminals, with police records.

A preliminary study of a man's hands, sufficient for writing such a formula as these, may be made directly on the hands themselves by means of a pocket magnifier. In some cases, too, as when a suspect is being held on the charge that he is a certain man, whose pattern formula is known, such a cursory examination may be sufficient to prove non-identity: where, however, anything more is needed, in all cases requiring careful study of individual patterns, some form of print or permanent impression is necessary. Prints are taken as follows:

Taking the Finger Prints. The manner of taking finger prints is in substance as follows: A very thin film of printer's ink having been rolled evenly on a glass plate, each finger in turn is taken by the operator, who stands on the left of the person whose prints are being taken. The finger bulb is placed upon its side and lightly rolled to the opposite side; then as lightly rolled on the paper form in the place designated as that for the impression of that particular digit. The practice of rolling the fingers when printing from them is necessary in order to impress enough of the surface to insure that the points at which the boundaries of the patterns begin to diverge — *i. e.*, the deltas — shall always be included.

The impressions are recorded in the following order:

Upper row: Rt. thumb; Rt. index; Rt. middle; Rt. ring; Rt. little.
Lower row: Lft. thumb; Lft. index; Lft. middle; Lft. ring; Lft. little.

In most cases *plain*, or "dab," impressions (made without rolling) are taken also by placing the bulbs of the four fingers, omitting the thumb, first on the inked glass and then on the paper simultaneously, without any rolling or turning movement whatever, and with the fingers held close together. Figure 77 shows the manner in which both rolled and plain finger prints are usually recorded.

The main value of a set of plain impressions is to give the correct order of the patterns, and check any error made in placing the rolled ones; they are also inclined to be a trifle clearer, and offer in general the advantage that comes from the chance to examine more than one print. There is an additional advantage, that of comparing the plain inked impressions with chance impressions found at the place where a crime had been committed, as, almost without exception, the chance impressions will be in the same form, and if more than one, in the same order as the plain impressions. Sometimes the plain impressions of both thumbs are also taken. These must be impressed separately from the fingers in order to get the pattern.

To prepare the glass plate in the first place, the ink should cover the surface evenly, and to the right depth. A printer's roller should be used,— that is, a roller made from glue and molasses,— although, when nothing better is available, fairly good results may be obtained from the cheap rubber rollers commonly sold with photographic supplies. The glass

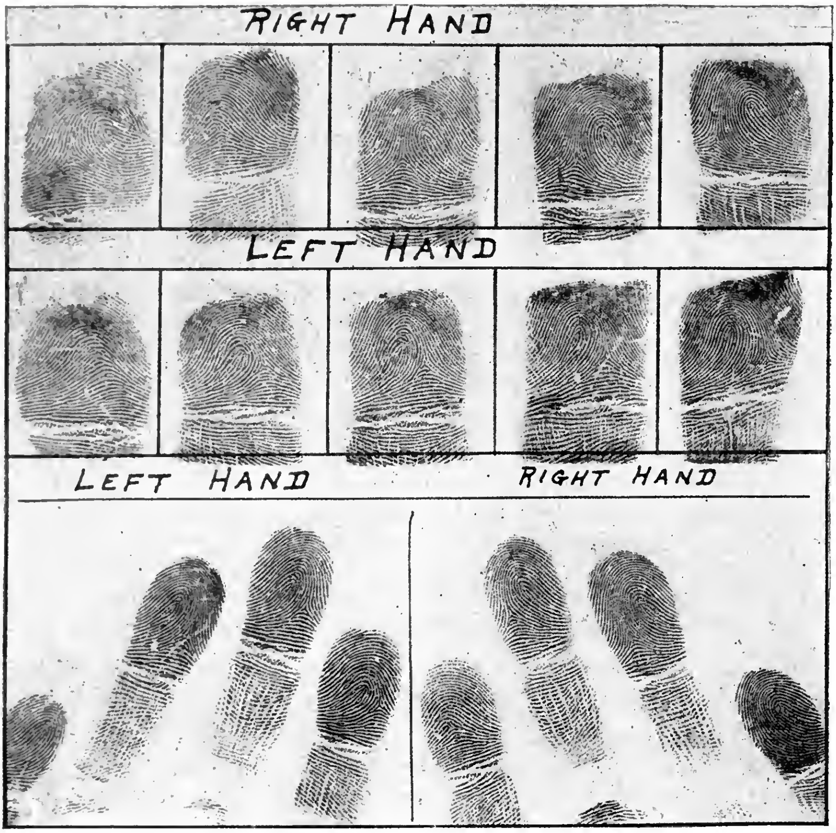


FIGURE 77. Complete finger print record of a little girl, R. E. P. The two upper rows are rolled impressions. The two spaces below contain plain impressions, all four of each hand made at the same time.

surface should be perfectly clean to begin with, and a bit of ink should be placed upon it and rolled down in different directions, until the ink is evenly distributed. Use a little at first, and then add more, bit by bit, rolling between the additions. After each impression all the lines of the previous one must be wholly rolled out, as otherwise there will be a surcharge.

Each time, when the work is finished, the ink should be wholly cleaned from both plate and roller by the use of benzine, or gasoline and when not in use the roller and plate should be kept in a place free from dust and lint. The operator should make it a point *to obtain the best prints possible*, for success depends upon the clearness of the inked impressions and the accuracy of their classification.

Pattern Areas, Deltas and Cores. All patterns except Arches, which are in reality no patterns at all, possess certain elements which are essential to a proper understanding of these structures. These are the *pattern area*, the *delta* or *deltas*, and the *core* or *cores*.

The deltas, as in the interpretation of a palm, are the first points to

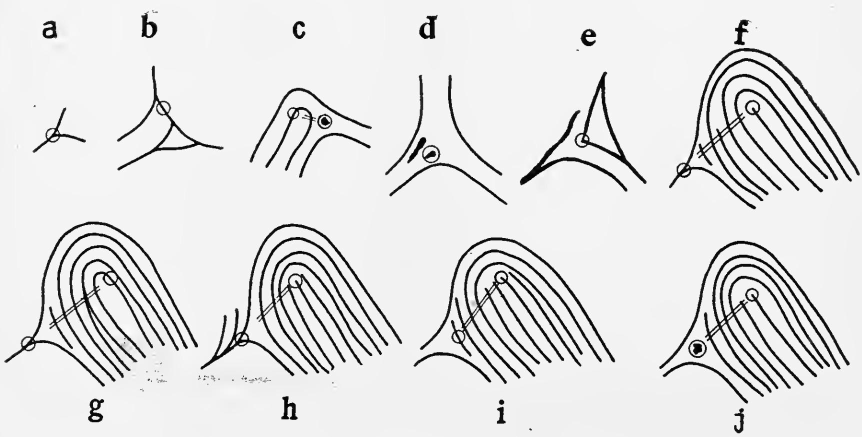


FIGURE 78. Cores and deltas of loops, showing various methods of construction.

be looked for. These points give the appearance of triangles or often of three-pointed stars, but the careful study of the ridges composing them shows that they may be formed in a variety of ways (Figure 78). Henry describes the usual formation as made "either by the forking of a single ridge, or by the wide separation of two ridges that up to this point had run side by side"; having in mind the ridges that come in from the margin of the friction skin, and approach the bulb. Thus it may appear in the typical form of the three-pointed star (Figure 78 *a*), that is, a capital Y with the two arms widely spread; again (*b*, *c* and *d*), the delta is the nearest ridge or dot in front of the divergence of the two ridges that until then had been parallel. It is also possible to find a delta without a definite center, where the idea of the triangle is expressed by the proper bending and forking of the ridges (*e*). There are, however, frequent cases of such irregular formations as *e* that may require some little thought as to which point

is to be taken as the delta. In general this *point of delta* may be defined as the point where there is a forking of a single ridge, or the ridge or island in front of the angle caused by the divergence of the two ridges mentioned. In Figure 78 the point of each delta is the center of the circle where the ridge forks or where two separate, and in all cases where the word delta is used the point of delta is intended. In almost every case there may be selected three ridges radiating from the point of delta, the *radiants*, and here, as in the palms and soles, these ridges may be followed by tracing them with ink. Occasional cases may be met with where, within the

FIGURE 79. Print from the right middle finger of J. C., 2×. Code word, UNEASY.

FIGURE 80. Same as Figure 79, with the pattern area removed, 2×. Compare the two figures.

general delta area, there are two or more forked ridges spreading out to form radiants; that is, two or more deltas or points of delta (Figure 78, *h*). Where a definite point must be fixed upon, as in ridge tracing or counting, the point of the delta nearest the point of core is taken.

The two inner radiants, those passing toward the middle of the phalange, are the ones to be followed, and will be found to define with more or less accuracy the region which includes the pattern, the *pattern area.* Where there is but one delta the boundaries of this area are definite ones, and cut the pattern out of its surroundings, so to speak, as clearly as could be done with the scissors. Such a case is shown in an Ulnar Loop in Figures 79 and 80, the first of which shows the entire print, without tracing; the second the pattern area traced and eliminated, leaving the surrounding field only. Here the lower radiant of the delta extends nearly horizontally across the pattern, defining the lower boundary of the pattern area, while

the upper radiant passes up, over, and down on the other side, thus forming a large loop in which the pattern lies. This upper radiant in this case emerges from the right-hand margin only a short distance from the lower, leaving a matter of but 8–9 ridges between them at their exit. The pattern is, however, still freely open and is definitely a Loop, and not a Whorl or Composite of some sort, as it would be if any of the ridges were recurved, as a result of being penned in. Loops are sometimes wider than this at the exit; others are narrower, and it is even possible to find those in which the two radiants fuse at the exit into a single ridge These are all considered as *Loops*, however, *so long as there is no recurved ridge.* One such ridge would form a delta, which would transform the pattern into a Whorl or allied form.

The *Core*, or center, of a pattern differs in the different types. In a perfect Whorl, formed by concentric figures, circles or ellipses, the core is the center about which the figures are arranged; in a typical Loop it is the terminal end of the central axis; but in actual cases, where its definition becomes a matter of ridges, there are many variations, and the exact location of the core becomes occasionally a difficult question.

The location of the core is mainly of importance in determining the ridge count of a Loop,— that is, the number of ridges intervening between the point of core and point of delta,— but at times it is equally necessary to find the core of a Whorl or Composite, for a similar purpose.

Often in a Loop pattern the axis of the Loop is formed by a single straight ridge or rod which is unmistakable, and the core can be readily fixed at the free upper end of this ridge, called the point of core. Frequently, however, the axis is in the form of a narrow loop, composed of two ridges, continuous over the upper end; or, again, it is composed of two, three, or more adjacent ridges, ending freely above, and not joined together. In all such cases the following rule is to be observed: *In the case of two ridges, whether connected or not, the one farthest from the delta forms the axis, and its highest point is the point of core; if there are three ridges, use the middle one, and if four, use the third one, counting from the side of the delta.*

Figure 81 shows the centers of various forms of Whorls; *e* is that of a double spiral where the ridges seem to approach the center contra-clockwise; as compared with Plate III, *e*, where the ridges run clockwise, or in the same direction as the hands of a clock. Various forms of cores and deltas in loops are shown in Figure 78, *f*, *g*, *h*, *i*, *j*. In *f* there is a single rod in the center, the point of delta being a single bifurcation; both point of delta and point of core are indicated by circles. In *g* there is a looped rod in the center; in *h* there are three rods, but with a compound bifurcation at the delta; in *i* there are four rods, with a parting, the nearest ridge in front being the point of delta; and in *j* there are two separate rods, with a

parting, the island being the point of delta. In all these illustrations of loops, the double line indicates the ridges that are counted.

An Arch has neither core nor delta, but a Tented Arch, which is really intermediate between an Arch and a Loop, possesses both.

A Whorl has two deltas, one on either side of the finger, and it is naturally seldom that the radiants from the two actually coincide across the pattern. The upper radiants are not considered in this, but *Whorls are subdivided into different types in accordance with the mutual relationships of the lower radiants.* Where the two either coincide, or come within two ridges either way of doing so, they are called *Meeting Whorls* (M); when

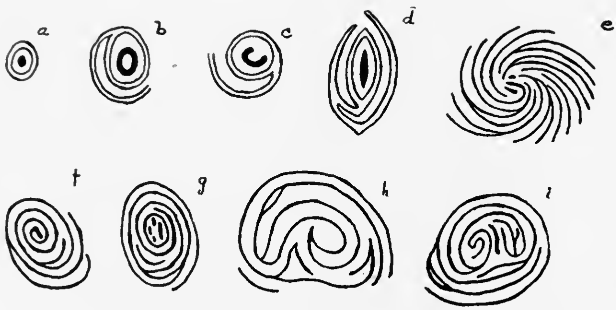


FIGURE 81. Details of several different cores from whorls, showing various methods of construction.

the one from the *left* point of delta (without reference to the hand the pattern came from) passes *below* the right point of delta by three or more ridges, the pattern is an *Outside Whorl* (O); when the same line passes *above* by three ridges the pattern is an *Inside Whorl* (I).

Summarizing, the following relations occur and may help in the determination of patterns:

A Typical Whorl has two deltas and one core.
A Spiral Whorl has two deltas and one or two cores.
A Composite has two deltas and one or two cores.
A Loop has one delta and one core.
An Arch has no delta and no core.

To this the Tented Arch is an exception, as it is a transition form between an Arch and a Loop. It has one delta and one core, close together.

The separate types of patterns may now be taken up in greater detail.

THE MAIN TYPES OF FINGER PATTERNS AND THEIR ATTRIBUTES

1. *Arches.*

In Arches the ridges run from one side of the finger bulb to the other, those ridges at or near the base running practically straight across the finger, the ridges above arching more and more the nearer they are to the finger tip. There is generally no delta, but when there is an appearance of one, no ridge must intervene between this and the core, which necessarily is present with the delta. This form of Arch is clearly the first step following a Loop, but no ridge intervenes between delta and core; in other words, if a ridge count of 1 can be obtained, the pattern is a Loop and not an Arch.

Tented Arches. In patterns of the Arch type there is a variation or modification known as the Tented Arch (Plate I, *b*), so called "on account of a vertical upthrust or spine from the middle of the base of the Arch, causing the ridges immediately above it to assume a shape not unlike the outline of a tent, leaving the remainder of the pattern but little disturbed."* There are some Tented Arches that have the appearance of Vertical Loops, if the term be allowed (Plate I, *c*), "but in order to demark clearly the line which separates Tented Arches from those Loops that have a more or less vertical trend, it is held that, *if on either side of the axis even one ridge recurves, the impression is a Loop.* The meeting of two ridges at a sharp* angle resulting from their running into each other, through not maintaining their parallelism of direction, is not to be confused with recurving. The recurving ridge must be wholly on one side of the axis." While nearly five per cent of all impressions taken will be of the Arch type, only about one in nine of these will be a Tented Arch.

2. *Loops.*

In Loops "some of the ridges double back upon their course and return approximately to the place where they started from, but no ridge makes a complete circuit." There is but one delta.

As explained above, Loops slope obliquely downward, opening either toward the thumb-side (radial) or toward the little-finger-side (ulnar). In accordance with this direction of the open end, Loops are classified as *Radial* and *Ulnar*. In a print, *which is just the reverse of the actual skin surface*, an Ulnar Loop on the right hand opens toward the right, and a Radial Loop to the left; while in the case of the left hand the reverse is true, Radial to the right, Ulnar to the left. In the actual hands, Ulnar Loops of the right hand open to the left, and Radial to the right; while in left hands the Radial Loops open to the left and Ulnar Loops to the right. This whole matter is rendered so confusing by the reversal of directions on the two hands, and again by the reversal between hands and prints

* Classification and uses of Finger Prints. Sir E. R. Henry.

that, for the beginning at least, it is best to use one's own hand for reference, whenever needed, as the direction of the two forms can there be seen at a glance. For this the reader has only to remember, *Radial, Thumb; Ulnar, Little Finger*, and also that the right hand corresponds to a left print, and *vice versa*. This method causes the worker to reason the whole thing out anew at every such consultation, and grounds him in the relationships as nothing else can. However, should he wish to learn a rule, *applicable to prints only*, he may be helped by the following:

On right hand prints; Ulnar to right, Radial to left.
On left hand prints; Ulnar to left, Radial to right.

which may be still further reduced, as:

Ulnar to its own side (*i. e.*, to right in right hand prints; to left in left hand prints).

In dealing with so common a pattern as the Ulnar Loop a method is naturally to be sought by which these may be subdivided, and thus distinguished from each other. This may be readily done by means of the *ridge count*, the method of which can be learned by inspecting figures *d*, *e* and *f* of Plate I, and Figures 137 and 138 of Chapter IX. In this the exact points for core and delta are definitely fixed by the rules given above. The two are then connected by a straight line (in the figures a double line) and those ridges are counted, and those only, which are directly crossed by the line. Thus, in Plate I, *e*, for example, the line happens to cross a small island, hardly wider than the line, but this is correctly included in the count, giving the pattern a count of 16. In the same way, Plate I, *f* shows a ridge count of 6, and Plate I, *d*, an example of the beginning of the series, a ridge count of 1. This latter is, as a matter of fact, a Radial, rather than an Ulnar, Loop, but this makes no difference in the ridge count or the method of making it, and the fact that the Loop is Radial rather than Ulnar, can be told only by knowing which hand it came from, in this case the right. In Figure 78, *g*, there is a fork crossed by the double line,—in such a case the fork is counted as two ridges.

An extremely puzzling form of pattern is shown in Figure 82, which admits of two interpretations, even by experts. This is plainly a transition form between a Loop and an Arch, with one ridge already doubled over in the loop form. Were it not for the short projection from the loop, the left-hand ridge of the loop would be selected as the core, and the pattern would be classed as a Radial Loop with a ridge count of 1, similar to Plate I, *d*; but with this projection there is formed on the loop itself a figure like a delta, and, if we follow the rule for double deltas, selecting this as the delta to count from, there would be no intervening ridge between that and the core. According to this interpretation the figure would be

an Arch. While there seems to be some support for this view, the authors incline to recognize the pattern as a loop, that has degenerated almost to the point of being an Arch.

A strict adherence to the rules for locating core and delta, and the rule that, if even one ridge intervenes, the pattern is a Loop, will usually be sufficient to decide in difficult cases; but here, as elsewhere, in transition and other doubtful cases, the alternate possibility may be expressed by

FIGURE 82. The central part of a disputed pattern, enlarged 8 diameters. If the short branch projecting from the innermost loop makes, with the loop, a delta, then the pattern is an Arch, approximating a Radial loop; code word, ABLE. If the fork on the next ridge to the right is the delta, then the pattern is a loop, approximating an Arch, with a ridge count of 1; code word, RIB.

an exponent letter, and the search may be made in the files in both places.

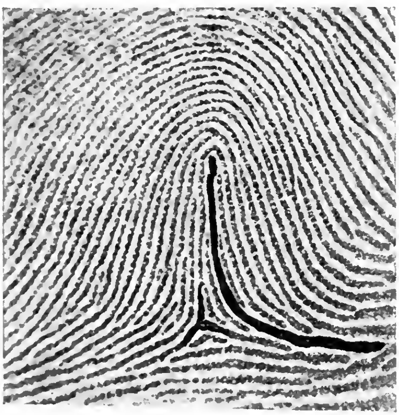
Certain cases of Ulnar Loops form the subject of a careful analysis in Chapter IX, and the ridge count is clearly shown in both photographs and diagrams. In Loops a ridge count as high as 38 has been observed, although the average falls at about 10, varying in the different fingers. A method of using this average, in dividing Loops into two approximately equal groups, is explained under *Classification*, farther on in this chapter.

Aside from the usual form of Loops, where the ridges simply recurve

PLATE I

a. Code word, ARCH

b. Code word, ARBOR



c. Code word, ARMOR

d. Code word, RIB

e. Code word, UNDERGO

f. Code word, UNCAP

Description of Plate I on Page 201

around the end of a central axis, there are variations known as the *Invaded Loop* and *Crested Loop*, first illustrated by Galton in his "Finger Prints." Examples of these are shown in Plate II, *a* and *b*. These, the first in particular, present an appearance as though a series of ridges were swarming over the pattern, coming from the side of the delta, and threatening to engulf it from above. Attaining the other side they are suddenly arrested by ridges going the other way, and forming the axis of the Loop, or a part of it, and either end blindly, or are swept into the current of the normal ridges, giving the appearance of a crest above the pattern area. In the example shown at *a* the invading ridges are few in number, and narrow to a point as they advance. This pattern doubtless is an evolutionary form of a Twin-Loop that has degenerated, while in *b* the invading ridges, about as numerous, are all stopped along a line which they cannot pass. This latter is doubtless a degenerated form of a Lateral Pocket. The outlet for the ridges is narrowed almost to the point of closure.

There is an extreme type of Loop where this shutting off actually takes place, and a round or oval pocket is formed about the core (Plate II, *c*, *d*, *e*). Patterns of these and similar forms, called Loops that approximate Central Pockets, are degenerated Whorls beyond a doubt (compare with Plate II, *f*, and Plate IV, *a*, *b*, *c*), but these approximations may always be distinguished by the presence or absence of recurved ridges; in other words, a delta, at the base of the pocket. If there is as much as a single recurved ridge, the pattern is classed as a Composite; if no ridges recurve, no matter how tightly they are drawn together, the pattern is a Loop, and is classed with Loops. Like ordinary Loops, both the Invaded variety and these approximations can be either Ulnar or Radial.

Radial Loops are rather infrequent, while Ulnar Loops are by far the most common of all finger patterns. According to a record compiled in Scotland Yard in 1905, which enumerates the patterns of 5,000 different persons, (50,000 different finger prints,) 31,852 of them, or nearly 64 per cent of the whole, were Ulnar Loops. The Radial Loops numbered only 2,833, about $5\frac{1}{2}$ per cent.

3. *Whorls.*

According to Henry's definition Whorls are patterns in which "some of the ridges make a turn through at least one complete circuit; there are

DESCRIPTION OF PLATE I

a. Arch, a pattern with neither core nor delta, and not approximating a loop of either sort, Radial or Ulnar. Code word, ARCH.

b. Tented Arch, a symmetrical specimen with no approach to either sort of loops. Code word, ARBOR.

c. Tented Arch, approximating an Ulnar Loop. Code word, ARMOR.

d. Radial Loop, approximating an Arch, with a ridge count of 1. Code word, RIB.

e. Typical Ulnar Loop, with a ridge count of 16. Code word, UNDERGO.

f. Typical Ulnar Loop, with a ridge count of 6. Code word, UNCAP.

PLATE II

a. Code word, USURE

b. Code word, USURER

c. Code word, UPREAR

d. Code word, UPLED

e. Code word, UPRIGHT

f. Code word, CLAW

Description of Plate II on Page 203.

two deltas, one to the left, the other to the right." These two deltas placed on the two sides of the pattern, are anatomically *Ulnar* and *Radial,* in position, the one being on the little-finger-side, the other on the thumb-side, of the pattern. Naturally, then, the sides are reversed on the two hands, so that, for instance, the ulnar delta is on the right side of the Whorl in a print from the right hand, and on the left side of the Whorl in a print taken from the left hand. Again, as a print reverses the sides of a pattern when compared with the surface of the real finger, a given delta will be on the right side of a finger but on the left side of the print of that finger. The condition is exactly that of Ulnar and Radial Loops, and if once thoroughly reasoned out for one, it is solved for the other. It would, therefore, be more scientific always to refer to the two deltas of a Whorl as the Ulnar delta, and the Radial delta, yet in practical work, according to the Henry system, this has not been done. A Whorl is often a nearly symmetrical pattern, without the noticeable difference between the sides that appears in a Loop, and thus, for the sake of simplicity, *all Whorls are treated alike, without reference to the hand from which they came. The two deltas are always the right and the left, as they are in the print.*

Whorls are divided into three groups, which on the average are found to occur with about equal frequency, and thus divide a collection of Whorl patterns into practically equal groups. These, with their abbreviations, are:

Inside Whorls I
Meeting Whorls .. .. M
Outside Whorls .. .. O

The class to which a given Whorl belongs is found by tracing the lower radiant from the left point of delta across the lower part of the pattern to the opposite side. When this is done, if the ridge from the left point of delta, which is the one upon which the decision rests, runs directly into the right point of delta, or if it passes the right delta, either above or below it, by not more than two ridges, the two lines are considered as meeting, and the Whorl is a Meeting Whorl. When the line traced from the left point of delta falls below the right point of delta by more than two ridges, the pattern is an Outside Whorl; and when, finally, the line passes above

DESCRIPTION OF PLATE II

a. Invaded Ulnar Loop, with a ridge count of 16. Code word, USURE.

b. Invaded Ulnar Loop, with a ridge count of 17. Code word, USURER.

c. Invaded Ulnar Loop, approximating a Central Pocket. Ridge count 14. Code word, UPREAR.

d. Invaded Ulnar Loop, approximating a Central Pocket. Ridge count 6. Code word, UPLED.

e. Invaded Ulnar Loop, approximating a Central Pocket. Ridge count 15. Code word UPRIGHT.

f. Central Pocket Loop, approximating an Ulnar Loop. Inside tracing, ridge count 15. Code word, CLAW.

the right point delta, also by more than two ridges, the pattern is an Inside Whorl. The line traced from the *left* delta, its lower radiant, is always considered to be the one upon which the decision rests, and a Whorl is considered to be either Inside, Meeting, or Outside, in accordance with the fate of this line. In an Inside Whorl the line from the left delta becomes shut within the pattern area, and is more or less involved, or wound up in the pattern itself.

Examples of these three forms of Whorl patterns are shown here on Plate III: *a* and *b* are Inside Whorls; *c* and *d*, Meeting Whorls; *e* and *f* are Outside Whorls. Figure *b* of Plate III, and Figures *e* and *f* of Plate IV, represent imperfect prints of Whorl patterns, where, nevertheless, the group may be ascertained. In Plate III, *b*, the left radiant becomes involved in the pattern, and leaves no possibility for a line from the right side, beyond the area, to come above it. Aside from this three ridges are seen to the right of it, neither of which can become involved in the formation of the right delta, and thus the pattern cannot be a Meeting Whorl. It is definitely an Inside Whorl, then, but the exact ridge count cannot be ascertained.

The patterns shown in Plate IV, *e* and *f*, are also incomplete Whorl patterns, but here, in both cases, it is the tracing from the right delta that surrounds the pattern and shuts out the possibility of receiving the line from the left within, or above, it. They are thus both Outside Whorls, and this decision is corroborated by a glance at Plate III, where, in Figures *e* and *f*, the same patterns are shown, more completely printed.

This comparison emphasizes well the need of always procuring rolled patterns, for while the group to which a Whorl belongs may sometimes be determined from the presence of a single delta, the ridge count, to be taken up later, which is often of great importance, cannot be made.

In prints of Whorls in which the pattern is complete, with both deltas, and in such only, the ridge count may be taken, and by it the patterns may be conveniently subdivided; but here the customary count is not that between either delta and the core, but *between the right point of delta and the line traced from the one on the left*. The cross line, upon which the count is taken, should be drawn perpendicular to the ridges to be counted, or as nearly so as the print permits. Thus, Figure *e* of Plate III is an

DESCRIPTION OF PLATE III

a. Inside Spiral Whorl, 3 intervening ridges. Code word, WABBLE.

b. Inside Whorl, intervening ridges three or more, but cannot be counted owing to the absence of right delta. Code word, WARP.

c. Meeting Whorl, no intervening ridges, many would class this as an elongated whorl, with code word WRAITH. Code word, WEAK.

d. Meeting Whorl, 1 intervening ridge inside. Code word, WEB.

e. Outside Whorl, 8 intervening ridges. Code word, WHEEL.

f. Outside Whorl, 5 intervening ridges. Code word, WHARF.

PLATE III

a. Code word, WABBLE (I)

b. Code word, WARP (I)

c. Code word, WEAK (M)

d. Code word, WEB (M)

e. Code word, WHEEL (O)

f. Code word, WHARF (O)

Description of Plate III on Page 204.

Outside Whorl with a ridge count of 8; and *f* of the same plate is Outside with a ridge count of 5. Since ridge counts of 1 and 2, both inside and outside, are classed with Meeting Whorls, the count for the I and O groups begins at 3, with nothing below.

In tracing the lines from the deltas, the following rules should be employed:

Start at the left point of delta, tracing toward the right point of delta. When the ridge ends, drop to the one underneath, or, when the ridge bifurcates, follow the lower member of the bifurcation, (*c*); then

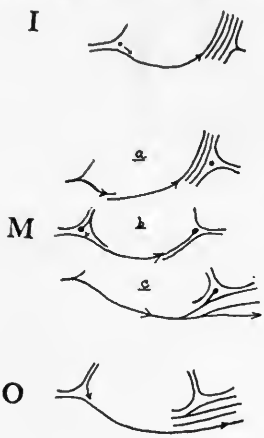


FIGURE 82½.

If the ridge traced passes *inside* the right point of delta, with three (3) or more ridges intervening, the pattern is classed as an Inside Whorl. Classification Symbol I.

If the ridge traced passes inside the right point of delta, with *not* more than two (2) ridges intervening (*a*);

or, actually meets the right point of delta (*b*);

or, passes outside the right point of delta, with *not* more than two (2) ridges intervening (*c*), the pattern is classed as a Meeting Whorl. Classification Symbol M.

If the ridge traced passes *outside* the right point of delta, with three (3) or more ridges intervening, the pattern is classed as an Outside Whorl. Classification Symbol O.

Some authors make a distinction between the usual type of Whorl, the pattern area of which is more or less circular in outline, and the *Elongated Whorl* drawn out in the up-and-down direction (Plate IV, *d*), so that the pattern area, and the ridges parallel with it, are in the form of a somewhat elongated oval. This distinction may be made wherever necessary,

DESCRIPTION OF PLATE IV

a. Central Pocket, outside tracing, with 11 intervening ridges. Code word, CHAR.

b. Typical Central Pocket, with inside tracing, with 11 intervening ridges. Code word, CALICO.

c. Central Pocket, approximating an Ulnar Loop. Inside tracing, with 7 intervening ridges. Code word, CLAN.

d. Elongated Whorl, outside tracing by three ridges. Code word, WRAP.

e. Incomplete print of Whorl, with left delta missing. Seen to be an Outside Whorl, but with number of ridges unknown. Print from the same finger shown in Plate III, c. Code word, WHEEL.

f. Incomplete print of whorl, with left delta missing. Seen to be an Outside Whorl, but with number of ridges unknown. Print taken from the same finger as Plate III, d. Code word, WHARF.

PLATE IV

a. Code word, CHAR (0)

b. Code word, CALICO (1)

c. Code word, CLAN (1)

d. Code word, WRAP (0)

e. Code word, WHEEL (0)

f. Code word, WHARF (0)

Description of Plate IV on Page 206.

either by separating the Elongated type from the rest, or by indicating them by exponent letters when writing out the formula; but it is difficult to draw a sharp line between the two, as every intermediate form exists between circles, ovals, and ellipses. Still, when a Whorl pattern is markedly elongated, it appears strikingly unlike the ordinary Whorl, and this difference led Purkinje, the first writer who attempted to classify patterns, to form for it his class of Amygdalæ, or Almonds.

4. *Composites.*

Aside from the typical Arches, Loops, and Whorls, with their varieties, the Tented Arch, Invaded Loop, and Elongated Whorl, there occur certain definite types of patterns, which at the beginning are apt to cause trouble. Anatomically they are related to the foregoing, and may be derived from them through transition forms, as was shown in the case of Invaded Loops and Central Pocket Loops, but for purposes of classification they can be treated as distinct, and placed, with all their differences, into a fourth main class, called collectively *Composites.* This class, co-ordinate in rank with Arches, Loops, and Whorls, modifies the original A. L. W. system of Galton into the A. L. W. C. system of Henry, and thus clears the atmosphere for the practical worker, who, instead of laboring separately with each case of these doubtful types, trying to decide whether a given form is a modified Loop or Whorl, simply refers it first to the class of Composites, and then to that form of Composite to which it plainly belongs.

The types of patterns classed as Composites are the following:

(a) Central Pocket Loops.
(b) Lateral Pocket Loops.
(c) Twin Loops.–
(d) Accidentals.

They will be considered in order.

4*a*. *Central Pocket Loops.* These are anatomically degenerated Whorls, in which one of the deltas has migrated to a point near the core, which cuts open the originally circular ridges behind it, and preserves those in front of it, the latter forming a pocket (Plate IV, *a*). The effect is therefore that of a Loop, which may be either Ulnar or Radial, about the core of which there has been imprisoned a little Whorl. This latter is the "Central Pocket," The same type is seen, with slight variation, in Figures *b* and *c* of the same plate, in both of which the central Whorl has assumed the form of a spiral rather than the more primitive one of concentric circles. Still another Central Pocket Loop is shown in Plate II, *f*, where it is used for comparison with the anatomically closely related figure, though classified elsewhere, a Loop approximating a Central Pocket. The

distinction between them, as set forth above, is the presence or absence of an inner delta, as indicated by the presence or absence of a recurved ridge.

The fact that, in the pattern here considered, the ridges embraced within the inner delta are of the Whorl type, while all the ridges outside of this help to form a Loop, causes the pattern to be considered both a Loop and a Whorl; that is, a Composite. Seymour says of it: "This pattern starts out to be a Loop, and changes its mind and becomes a Whorl. The space in the center, occupied by the insurgent ridges, so to speak, forms a pocket, within which are the ridges that deviate from the Loop pattern."

As in typical Whorls, there can be Inside, Meeting, and Outside Central Pocket Loops, and the ridges may be counted in the same way. Plate IV, *a*, is an Outside Central Pocket, with a count of 11 ridges; Plate IV, *b*, an Inside Central Pocket, with a count also of 11 ridges, and Plate IV, *c*, an Inside Central Pocket, with a count of 7.

4*b*, *Lateral Pocket Loops.*
4*c*, *Twin Loops.*

Both of these similar forms are complicated patterns composed of two loops, interrelated like the two parts of a letter "S." They may be considered Whorls, which have been drawn out sideways, with the two deltas wide apart. They thus seem to require considerable room for their full expression, and correspondingly the two together occur more frequently on thumbs than on all the other fingers together, and next to this on the index. On the last three fingers they are rarely found.

In both types each of the loops has a definite core, with its own central axis, and if these are traced, as can be easily done, the results will appear as shown in Plate V, *b*, *c*, *d*, and *e*. In *b* and *d*, the two cores, when completely traced, are seen *to enter the pattern from the same side*, in this case the right; while in *c* and *e*, when the cores are traced in the same way, *the two axes enter from opposite sides.* This, then, makes the most important distinction, but another may be found in the position of the right-hand delta. In Twin Loops *this delta ordinarly lies somewhere between the two axial lines*, while in Lateral Pocket Loops *it lies above both* (*b*), *or below both* (*d*), *and never between the two.*

Putting these distinctions in tabular form, we have:

I. In Lateral Pocket Loops the two lines forming the axes of the loops enter from the same side.

In Twin Loops the two lines forming the axes of the loops enter from opposite sides.

II. In Lateral Pocket Loops the right delta is placed either above both axial lines, or below both; never between them. In Twin Loops the right delta is usually situated somewhere between the two axial lines.

5. *Accidentals.* This group contains that relatively small number of

PLATE V

a. Code word, ALCOVE (I)

b. Code word, LIME (O)

c. Code word, TWIN

d. Code word, LADY (I)

e. Code word, TRACK (O)

a. An Accidental, with inside tracing, 10 intervening ridges. Code word, ALCOVE.

b. Lateral Pocket Loop, outside tracing, with a count of 13 ridges. This illustrates the necessity of rolling enough to include all the boundaries of the pattern area. Code word, LIME.

c. Twin Loop, the cores enter from opposite sides. Neither counting or tracing can be determined. Code word, TWIN.

d. Lateral Pocket Loop, inside tracing, with a count of 11 ridges. Code word, LADY.

e. Twin Loop, outside tracing, with a count of 4 ridges. Code word, TRACK.

patterns that are too irregular in form to be definitely classed in any of the above groups. It consists thus of a miscellaneous collection of patterns, unlike any of the regular types, and often unlike one another, which are called Accidentals for want of a better name. These patterns are quite infrequent, occurring but 64 times in 50,000 fingers. Curiously enough, too, 52 out of the 64 came from the index, thus marking Accidentals of all sorts as essentially index patterns.

In some Accidentals there can be a ridge count, and they can be sometimes determined as Inside, Meeting, or Outside Accidentals, in the usual

FIGURE 83. An unusual pattern with three loops. Such forms are rarely seen in the fingers, but are of frequent occurrence in toes. It could be classed as an accidental. The pattern has three deltas, the center one only can be seen here. The tracing is undoubtedly inside, and the Code word would be ALWAYS.

manner; in others, however, the eccentricity is too great to allow such application. Figure *a* of Plate V is plainly an Inside Accidental, with a count of 10 ridges; but *c* of the same plate is more of a puzzle, with one definite delta below and indications of an injured second one directly above it. By the application of the rule, that the two lines that form the axes of the loops enter opposite sides in the case of Twin Loops, this can be classified as a Twin Loop, although strictly speaking there is no separation of the two cores by the right delta. This pattern has also been classified by experts as a Tented Arch, on the ground that it "has but one delta and a spike," still another classifies this as "an Accidental — but a safe classification would be a plain Loop with a count of 3." This illustration

serves to impress upon us the necessity of making a search under more than one head, in the case of obscure patterns that cannot of a certainty be classified as any particular pattern.

Figure 83 is a rare type of Accidental with three loops. This type seldom occurs on fingers, but is frequently seen on toes.

When the finger print system of identification was first installed, the world was much in the dark concerning the actual occurrence of the various types, as the data at hand were too few to yield definite results. It was apparent from the beginning, however, that the thumb and index finger were more variable than the rest; that the Ulnar Loop was by far the commonest type; that this was met with most frequently in the last three fingers, and so on; but these supposed facts came from short experience, and were not substantiated by definite data. In 1905 Scotland Yard was able to present the statistics of the patterns of 5,000 individuals, yielding 50,000 impressions, which seems a sufficient number upon which to base fairly accurate percentages of occurrence. These were taken separately for each of the five fingers of each hand, and are presented here:

TABLE SHOWING THE OCCURRENCE OF EACH TYPE OF PATTERN ON EACH OF THE TEN FINGERS OF 5,000 INDIVIDUALS (50,000 IMPRESSIONS).

Digit	Whorls	Lat. P. Twin L.	Central Pockets	Acci-dental	Ulnar	Radial	Tented Arch	Arch	Amput. or Damaged
Right Thumb	1588	438	37	2	2786	11	1	122	15
Right Index	1241	146	119	21	1602	1291	114	425	41
Right Middle	695	69	57	2	3719	126	30	273	29
Right Ring	1735	32	274	4	2769	73	1	91	21
Right Little	568	19	100	Nil	4254	10	Nil	27	22
Left Thumb	957	491	18	Nil	3287	10	Nil	225	12
Left Index	1094	174	100	31	1893	1161	97	418	32
Left Middle	657	105	40	3	3647	125	43	354	26
Left Ring	1100	53	231	Nil	3429	25	4	133	25
Left Little	341	31	76	1	4466	1	1	57	26
Totals	9976	1558	1052	64	31852	2833	291	2125	249

On page 79 of "Classification and Uses of Finger Prints," by Sir E. R. Henry, the percentage of the different types of patterns is given as, "Arches, 5 per cent; Loops, 60 per cent; Whorls and Composites, 35 per cent." It will be noticed that in the above table the percentage of Loops is larger, and that of Whorls smaller, than given by Henry. Experience has shown, however, that the percentage given by Henry is nearer the average the world over.

The Classification of Finger Print Records

Although individual finger patterns thus admit of careful description, and of classification into types and varieties, the system would not be very

serviceable when dealing with thousands of individuals unless the records, in practically any number, could be so arranged in order and filed by some competent methods, which would enable one to find quickly and easily an individual record. The importance of classification was well expressed by the late executive secretary of the New York Police Department, Robert J. Kennedy: "Finger Prints, to be of any value, must be classified in such a way that a record of any person may be quickly found at any time, regard'ess of name, photograph, or physical description." Accordingly, a large part of the labors of the founders of the finger-print system has been devoted to formulating and systematizing records with this end in view.

The system of classification now in general use is based upon entire sets of prints rather than the prints of single fingers, although even this latter has been perfected and put into actual use by Oloriz in Madrid, and is destined to become of general use. There is first a *Primary Classification*, by which the poss'ble formulæ are divided into 1,024 separate groups or *classes;* and there are then several practical methods of *Secondary Classification*, by which each of these classes may be further subdivided to the extent desired.

A. The Primary Classification of Sir E. R. Henry

This method, now in general use and hence known to all finger-print experts, is best described in the words of the one who devised it, as found in his manual of the finger-print system. It is described as follows:

"The rolled impressions of the digits are recorded in their natural order of thumb, index, middle, ring, and little finger — those of the right hand being in line above, immediately below them the impressions of the corresponding digits of the left hand. At the bottom of the slip the plain impressions of the index, middle, ring and little fingers of both hands are also taken. It is essential to correct classification that the digits should be printed in their proper sequence; and as it could happen, through inadvertence on the part of the operator, that the impression, say, of the right index might appear as that of the middle or ring finger, the following check is provided. After the rolled impressions have been taken, the index, middle, ring and little fingers of each hand are dabbed down on the paper so that the imprints of their first phalanges are simultaneously made, and they must of necessity appear in their proper sequence. When slips are being classified their plain prints are invariably compared with the rolled impressions. This check, simple as it may appear, proves completely effective."

"We have the same number of combinations for the *second* pair, and, as each of these can be combined with each arrangement of the thumb and index, the total combinations of the two pairs taken together is 16. The third pair has similarly four arrangements, which, taken with those of the

preceding two pairs, raises the number of combinations to 64; adding the fourth pair this number rises to 256, and with the fifth pair to 1,024. The number 1,024 is the square of 32, so a cabinet containing 32 sets of 32 pigeon-holes arranged horizontally would provide locations for all combinations of Loops and Whorls of the ten digits taken in pairs."

Following the above possible arrangements of Loops and Whorls on the first pair, a very ingenious key was adopted to control the filing of the slips by their primaries. The key was arranged like this and the slips filed as follows:

$$\text{Key}\quad \begin{array}{|c|c|} \hline \dfrac{LL}{WL} & \dfrac{LW}{WW} \\ \hline \end{array}$$

To simplify the formulation of the patterns, Henry puts Loops and Arches together and calls them all *Loops*, indicated by the symbol L. In the same way he groups Whorls with Composites (and Accidentals) under the name of *Whorls*, with the symbol W. These two letters are thus the only ones used in writing finger-print formulæ, which are expressed in the following way: —

The fingers are first arranged in pairs; thus: —

1st pair,	Rt. thumb and Rt. index
2nd pair,	Rt. middle and Rt. ring
3rd pair,	Rt. little and L. thumb
4th pair,	L. index and L. middle
5th pair,	L. ring and L. little

A pattern formula for the complete set is written out by using L and W for the kinds of patterns, and expressing the five pairs of digits in the form of as many fractions. The numerator gives the pattern for the first of each pair; the denominator that for the second. Here is a typical case: —

$$\frac{W}{L}; \quad \frac{L}{L}; \quad \frac{L}{W}; \quad \frac{W}{L}; \quad \frac{L}{L}$$

The order of the digits, as here expressed, is as follows: —

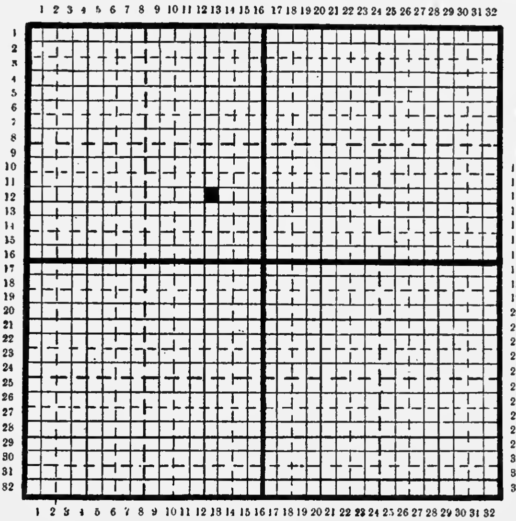
$$\frac{\text{rt. thumb}}{\text{rt. index}} \quad \frac{\text{rt. middle}}{\text{rt. ring}} \quad \frac{\text{rt. little}}{\text{l. thumb}} \quad \frac{\text{l. index}}{\text{l. middle}} \quad \frac{\text{l. ring}}{\text{l. little}}$$

It will be seen that any one of these pairs, the first for instance, is capable of four forms; Loop-Loop; Loop-Whorl; Whorl-Loop, and Whorl-Whorl, or: —

$$\frac{L}{L}; \quad \frac{L}{W}; \quad \frac{W}{L}; \quad \frac{W}{W}$$

which, using the first pair alone, will divide any collection of finger-print formulæ into *four* groups.

For the purpose of illustration, we will take a set of finger prints obtained from J. N, arrange them in pairs as suggested by Mr. Henry, the symbols would then be LL — WW—LW — WL — WL. The key will indicate the one pigeonhole out of the 1,024 where a card with the above formula will be found.



"Referring to the key, LL is in the top left-hand square, defined by the horizontal figures 1 to 16 and vertical 1 to 16. The next pair WW is in the bottom right square of this, defined by the horizontal figures 9 to 16 and vertical 9 to 16. The next pair LW is in the upper right square of this last, defined by the horizontal figures 13 to 16 and vertical 9 to 12. The next pair WL is in the bottom left of this last, defined by the horizontal figures 13 to 14 and vertical 11 to 12. The last pair WL is in the bottom left of this last, defined by the horizontal figure 13 and vertical 12; *i. e.*, in pigeonhole $\frac{13}{12}$, shown in the key as all black. Classification numbers run from 1 to 32 of each horizontal row and not from 1 to 1,024, thus $\frac{13}{12}$ represents the 13th pigeonhole of the 12th horizontal row."

"Arithmetical rule for determining primary classification, etc. Simple as is the method of determining the primary classification number with the aid of the key to the cabinet, it can be even more readily arrived at in the following way, which enables the searcher to dispense altogether with the key.

"The digits, as before, are taken in pairs, the first of the pairs being shown as numerator and the second as denominator, the formula of J. N., as before, being of the following kind:

$$\frac{L}{L};\ \frac{W}{W};\ \frac{L}{W};\ \frac{W}{L};\ \frac{W}{L}$$

"When a Whorl occurs in the first pair it counts 16, in the second pair it counts 8, in the third 4, in the fourth 2, and in the fifth 1; no numerical value is given to a Loop. The above formula can then be expressed as: $\frac{0}{0};\ \frac{8}{8};\ \frac{0}{4};\ \frac{2}{0};\ \frac{1}{0}$. Numerators are added together, also denominators

and the totals exhibited as a new fraction $\frac{11}{12}$. To both numerator and denominator 1 is added, making $\frac{12}{13}$."

The reader will notice this fraction of $\frac{12}{13}$ causes the slip to go in a different pigeonhole from the one found by the key, hence the necessity of reversing the fraction, and by so doing obtaining $\frac{13}{12}$ the same as obtained by the use of the key. This was the reason and the only one for reversing the fraction, that the records classified numerically would file with the records previously classified by the use of the key. Continuing the illustration, the prints from J. N., as taken, were in the following order: $\frac{\mathrm{U\ \ R\ \ W\ \ W\ \ U}}{\mathrm{W\ \ W\ \ R\ \ W\ \ U}}$ —, and if we take the values obtained from the right index, right ring, left thumb, left middle, and left little for the numerator, by adding 1 we obtain 13; and taking the values of the right thumb, right middle, right little, left index, and left ring for the denominator, by adding 1 we obtain 12, and the completed fraction $\frac{13}{12}$. One of the authors was shown in the bureau of a large police department a thin sheet of metal marked off in ten squares the same size as the sheet they were using, every other square was cut out, and this, laid a certain way on the finger-print record, exposed only the five impressions used in making up the values of the numerator; the sheet of metal reversed, then exposed the five impressions used in making up the values of the denominator. As a device to prevent errors and save time, it was a most valuable addition to the equipment of that department.

B. *The Primary Classification, as modified by the present authors.*

The method of formulating the ten fingers, as presented above, has now been in use wherever finger-print identification is employed, and has thus been given a thorough test. In this testing process the inevitable slight defects, as well as the great merits, of the system have been revealed; and it is felt by the authors that the time has come to suggest a few minor modifications, the necessity for which has long been obvious to all professionals. The most essential of these is *the pairing of the corresponding fingers of the two hands, thus putting the entire right hand into the numerator and the left into the denominator.* That is, instead of pairing the right thumb with the next finger on that hand, the index, and so on, the two thumbs are paired, then the two indexes, the two middles, the two rings, and the two little fingers.

Eventually such a change must be made, just as surely as the metric system of weights and measures must eventually replace in England and the United States the older system so long in use. The change is after all a slight one, and a translation of a formula from one system to the other may readily be made. A collection of the records of 10,000 individuals could be changed over by an ordinary clerk in a few days, and the new formulation, added to the existing card, would in no way injure the old

record, which would thus be as available as before for those who still classify by the present method. Then, too, where the average age of the individuals recorded, criminals and the members of the army, is somewhere about thirty, another forty years, at the usual death rate, would find practically the entire set thrown out, and replaced by new ones, so that if a modified system were adopted now, all traces of the old would be lost in this comparatively short period. It is not a difficult task to make such changes as are here advocated, and the gain for all future time would be beyond computation, while even from the start, and during the time of changing over, there would be no necessary confusion.

As this book is written for the future rather than for the immediate present alone, the modified Primary Classification, as suggested by practice, and as actually used now for several years by the authors, is here given.*

We may begin by writing out a formula like those described above, with the ten patterns represented by letters designating the types and placed in the form of a fraction, *but with the five designations for the right hand in the numerator, and those for the left in the denominator.* Naturally, too, in the case of both hands, the thumb is placed at the left, with the other fingers in the natural order. The whole expression is then given a numerical value by the following method:

I. The *four* main types of patterns are reduced to *two* by classing Arches with Loops, and Composites with Whorls, thus:
   1. Loops (including Arches).
   2. Whorls (including Composites).

II. Arbitrary numerical values are assigned as follows:
   A Whorl in a thumb counts 16.
   A Whorl in an index counts 8.
   A Whorl in a middle finger counts 4.
   A Whorl in a ring finger counts 2.
   A Whorl in a little finger counts 1.
   A Loop, wherever found, counts 0.

It is to be understood that in the above Whorls and Loops are used as in the Henry system, and include respectively Composites and Arches. Accidentals also are classed with Whorls.

The application of this can be seen at a glance by taking some of the formulæ used above as illustrations, and translating them into numbers.

*It will be seen that in this presentation much of the Henry system is retained, and that the most radical change is in the method of pairing the fingers, thus bringing one entire hand above the line, and the other below (right hand = numerator; left hand = denominator). The ingenious method of assigning numerical values to the Whorls, and what comes out of it, is in the unmodified Henry system. We have employed this arrangement of material in order to present consecutively the entire procedure, as employed by us.

To these one or two more formulæ are added, to give greater variety to the results.

$\frac{W-T-U-U-U}{U-T-U-U-U}$	$\frac{16-0-0-0-0}{0-0-0-0-0}$	=	$\frac{16}{0}$
$\frac{U-T-U-U-U}{U-U-U-U-U}$	$\frac{0-0-0-0-0}{0-0-0-0-0}$	=	$\frac{0}{0}$
$\frac{C-W-U-U-U}{C-U-U-U-U}$	$\frac{16-8-0-0-0}{16-0-0-0-0}$	=	$\frac{24}{16}$
$\frac{U-A-U-U-U}{A-U-U-U-U}$	$\frac{0-0-0-0-0}{0-0-0-0-0}$	=	$\frac{0}{0}$
$\frac{W-W-W-W-U}{W-W-W-W-U}$	$\frac{16-8-4-2-0}{16-8-4-2-0}$	=	$\frac{30}{30}$
$\frac{A-W-U-W-U}{U-U-W-C-W}$	$\frac{0-8-0-2-0}{0-0-4-2-1}$	=	$\frac{10}{7}$
$\frac{C-W-W-U-W}{W-W-C-W-W}$	$\frac{16-8-4-0-1}{16-8-4-2-1}$	=	$\frac{29}{31}$

As is shown by the right-hand column, the fractions, after the assignment of the numerical values, are consolidated by adding the terms together in the usual way. In order to avoid all 0's, and especially the oft-recurring fraction $\frac{0}{0}$, there is always added the fraction; $\frac{1}{1}$; so that the above formulæ, reduced to the single numbers, and with the addition of the $\frac{1}{1}$, given in the order above, will read as follows:

$$\frac{17}{1} \quad \frac{1}{1} \quad \frac{25}{17} \quad \frac{1}{1} \quad \frac{31}{31} \quad \frac{11}{8} \quad \frac{30}{32}$$

Surprising as it may seem at first, this scheme works backward as well as forward, and the complete formula, with all ten prints written out in terms of the two (not the four) pattern types, can be obtained from the final fraction. To do this we use the following rules:

1. Subtract the fraction $\frac{1}{1}$ from the fractional formula.
2. Take numerator and denominator separately, that is, take one hand at a time.
3. Subtract from the number given the numbers 16, 8, 4, 2, and 1 in succession. This resolves the total into the numbers which denote the Whorls present.

Apply these, for illustration, to the third of the above formulæ, $\frac{25}{17}$, we first subtract the $\frac{1}{1}$, which gives $\frac{24}{16}$. From the 24 take 16, leaving 8; then take 8, leaving 0. The numerator (right hand) thus consists of the

two numbers 16 and 8, and could not be made with any other combination of the five numbers involved. There is therefore a Whorl (or Composite) on the thumb and index fingers, while the rest are Loops or Arches. The denominator, 16, shows at once a Whorl on the left thumb, and the rest Loops or Arches.

In the same way treat the last fraction, $\frac{30}{32}$. This becomes $\frac{29}{31}$ by the subtraction of the $\frac{1}{1}$. The 29 is easily resolved into a 16, leaving 13, then an 8, which leaves 5, then a 4, which leaves 1, and thus indicates the presence of Whorls on thumb, index, middle and little fingers of the right hand (16 + 8 + 4 + 1). The 31 of the left hand can be attained only by a succession of five Whorls, 16 + 8 + 4 + 2 + 1 = 31, making the highest possible score.

But, aside from this use of the simplified formula, which is a condensed description of the actual condition in a given set of finger prints, this fraction indicates with precision the place of the set in a filing cabinet. Such a cabinet has 32 drawers, or long compartments, into which the individual records are placed, *by their denominators*, which are naturally numbered from 1 to 32. The first, second, and fourth of the above seven formulæ go in Drawer Number 1; the sixth goes in Drawer Number 8; the third in Drawer Number 17, and so on.

Inside of each of the 32 drawers there are found 32 compartments, or perhaps in a small collection, simple manila folders, and these are numbered, *in each drawer*, by the numerators (1 to 32). In this way there are 32 x 32, or 1,024 compartments, accommodating the same number of possible fractional pattern formulæ, and each is filed in its own proper place. Of the seven examples above given, the card bearing the first formula on the corner would go into the 17th folder of Drawer Number 1; the third into the 25th folder of Drawer Number 17, the fifth into the 31st compartment of Drawer Number 31, and the seventh into the 30th compartment of Drawer Number 32, the last one in the cabinet. Two, even in this small collection, go together into the same compartment, $\frac{1}{1}$, which is the commonest of all, and is the first to call for farther subdivision.

Thus the endless variety of human finger prints, set by set, can be arranged in 1,024 different kinds, and be put into a cabinet with a like number of compartments, by means of using merely the distribution of the main types of patterns. This is the *Primary Classification.*

It is here to be noted, that, while the Primary Classification is based upon entire sets, having the ten fingers, it is possible to file away, and afterward find readily, incomplete sets, lacking one or more fingers, up to a certain point. If, for example, the thumb and little finger are wanting on a left hand, while the index is an Arch (0), the middle finger a Whorl (4), and the ring finger also a Whorl (2), making a count of 6 for the three, we could then have only the following possibilities:

Thumb a Whorl; little finger a Whorl,	16 + 1 = 17.
Thumb a Whorl; little finger a Loop,	16 + 0 = 16.
Thumb a Loop; little finger a Whorl,	0 + 1 = 1.
Thumb a Loop; little finger a Loop,	0 + 0 = 0.

Adding the known value of the rest of the hand, 6, we have for the possible denominator 23, 22, 7, or 6, and with the right hand complete and giving a value of, say, 28, it will be necessary to search only in the 28th compartment of Drawers 23, 22, 7, and 6; that is, in four compartments out of the 1,024. With an entire hand gone and the other complete, the task would be a little longer, but, even then, it would mean only the searching through one entire drawer, if the left hand were the one present, or in a single compartment in each of the drawers, if the right hand were the one present. Always bear in mind that *the left hand gives the number of the drawer; the right that of the compartment.*

C. *Secondary Classification*

This term includes the various methods of further subdividing each of the 1,024 separate classes obtained by the Primary Classification, and represented by some fraction from $\frac{1}{1}$ to $\frac{32}{32}$. Not all of these methods are necessarily to be employed, but they give certain convenient methods which may be applied according to the needs of the individual collection, and according to personal preference. They will suggest also other ways of effecting the same result, as may be developed bythe in genious reader.

It will be seen that the separate methods are not applicable to all of the classes, but that certain ones are especially, or even exclusively, to be used for collections containing only Loops, or Loops and Arches; and that others are to be used in connection with Whorls. This whole matter is so much one of individual need and individual preference that the authors content themselves here with describing the principal methods now in use, leaving the application to the individual workers. Naturally a small collection does not need as much subdividing as does a large one and in the former case a given set of prints could be readily found if only the largest classes were subdivided, and these by the use of perhaps a single method. However, it would be difficult to send so brief a formula as would here be employed to a large bureau and expect the search to be made as quickly, and it is thus to be recommended *that, even in a small collection, the individual prints be formulated to considerable detail, to facilitate the search elsewhere.*

The methods of Secondary Classification in common use, some applicable only to collections consisting of Loops only $(\frac{1}{1})$; others having a wider application, are the following:

a. *Subdividing by the Index Patterns.*

1. When all types of patterns are present.
2. When Whorls have been eliminated.
3. When Whorls and Arches have both been eliminated and the patterns consist wholly of Loops.

b. *Subdividing by the Index and Middle finger Patterns,*

1. When all types of patterns are present.
2. When Whorls have been eliminated.
3. When Whorls and Arches have both been eliminated, and the patterns consist wholly of Loops.

c. *Subdividing by the Arch Combination in the* $\frac{1}{1}$ *Primary.*

d. *Subdividing Radial and Ulnar Loops (without Arches) in the* $\frac{1}{1}$ *Primary.*

e. *Subdividing by Ridge Tracing.*

f. *Subdividing by Ridge Counting.*

g. *Subdividing by Arch Pattern Distribution in the* $\frac{1}{1}$ *Primary.*

h. *Subdividing by the Ridge Count of single fingers.*

1. Right little finger.
2. Right little finger and right thumb.
3. Right little finger, right thumb, left thumb, etc.

These will be taken up in order.

(*a.*) *Subdividing by the Index Patterns.* This consists simply of grouping all the sets in a given compartment according to the possible combinations of index patterns. Dividing Composites and Whorls into Inside, Meeting, and Outside (I, M, O), and including Tented Arches with the more typical sort (A), the possible combinations are the following, the right index pattern above, the left below, as usual:

$$\frac{\text{A A A A A A}}{\text{A I M O R U}} \qquad \frac{\text{I I I I I I}}{\text{A I M O R U}} \qquad \frac{\text{M M M M M M}}{\text{A I M O R U}}$$

$$\frac{\text{O O O O O O}}{\text{A I M O R U}} \qquad \frac{\text{R R R R R R}}{\text{A I M O R U}} \qquad \frac{\text{U U U U U U}}{\text{A I M O R U}}$$

Each of these 36 groups constitutes a subclass, under which the records included in one of the primary classes may be filed. In certain of the classes, however, especially in the two extremes $\frac{1}{1}$ and $\frac{32}{32}$, the number of these subdivisions suffers a necessary reduction, since the patterns are not all present. In class $\frac{32}{32}$, which is the most exclusive, the index formula present is naturally I, M, or O, on both right and left, since in this class all the patterns are Whorls, yet these give *nine* combinations. In class $\frac{1}{1}$ conditions are also good, since, although there are no Whorls, which eliminates all of the 27 subdivisions with an I, M, or O in them,

there are still Arches, Radial and Ulnar Loops, and the possible subdivisions are also 9; viz.:

$$\frac{\text{A}\quad\text{A}\quad\text{A}\quad\text{R}\quad\text{R}\quad\text{R}\quad\text{U}\quad\text{U}\quad\text{U}}{\text{A}\quad\text{R}\quad\text{U}\quad\text{A}\quad\text{R}\quad\text{U}\quad\text{A}\quad\text{R}\quad\text{U}}$$

In about half of the class $\frac{1}{1}$ there are no Arches present, nothing but the two kinds of Loops, yet to subdivide these there are still the following four combinations, which may be used if desired:

$$\frac{\text{R}\quad\text{R}\quad\text{U}\quad\text{U}}{\text{R}\quad\text{U}\quad\text{R}\quad\text{U}}$$

(*b.*) *Subdividing by the Patterns of the Index and Middle Fingers.* This method of furnishing subdivision for the purpose of breaking up too large accumulations under the primary classes, is like the last, but uses *two* fingers of each hand, instead of *one*, and thus greatly increases the number of the subdivisions. Starting, as in the first case, with those classes that contain all types of patterns, as here used, A, I, M, O, R, U, we have, for the possible combinations from right hands alone (numerators):

AA AI AM AO AR AU IA II IM IO IR IU MA MI MM MO MR MU
OA OI OM OO OR OU RA RI RM RO RR RU UA UI UM UO UR UU,

in all 36. But there are naturally the same combinations for the left hands (denominators), and thus, with each of the 36 numerators there can be any one of the 36 denominators, or 36 x 36, which equals 1,296. Certainly any class that contains representatives of all types of patterns would seem thus to be sufficiently subdivided. Now there are some Whorls present, one at least, in all of the classes except $\frac{1}{1}$, yet here, with Arches and Radial and Ulnar Loops only, there are 9 different combinations for each hand, AA AR AU RA RR RU UA UR UU, in all 81. When the Arches fall out, as in about one-half of the $\frac{1}{1}$ class, there are left 4 possibilities for each hand, RR RU UR UU giving 16 for the two-hand combinations, $\frac{\text{RR}\quad\text{RU}\quad\text{UR}\quad\text{UU}}{\text{RR}\quad\text{RR}\quad\text{RR}\quad\text{RR}}$, etc.

(*c.*) *Subdividing by the Arch Combination.* This method was devised in the United States for the purpose of breaking up the accumulation of prints filed under $\frac{1}{1}$, by far the largest of all. It consists simply of *giving the Arches the same numerical values as those assigned to the Whorls in making the primary classifiication;* 16 for an Arch on the thumb, 8 for one on the index, 4 for one on the middle finger, and so on. As with the Whorls, these values are to be added, and 1 added to both numerator and denominator. This naturally furnishes the very large number of 1,024 subdivisions, for all cases under $\frac{1}{1}$, where there are Arches, that is, about half

of the group. This fraction is written in the formula after and above that of the ridge count of the right little finger, usually in red ink, and makes the individual record so distinctive that the search for a given set is greatly facilitated.

(*d.*) *Subdividing Radial and Ulnar Loops (without Arches) in the* $\frac{1}{1}$ *Primary.* After disposing of all the Arches, the remainder of the $\frac{1}{1}$ class, about one-fifth of the whole collection, possesses a large number of Radial Loops in addition to a much larger number of Ulnar Loops. These, in the case of a large collection, require further subdivision. For this the following method is available. By the use of the index and middle fingers of both hands, these 16 combinations may be employed,

$$\frac{RR}{RR}\quad\frac{RU}{RR}\quad\frac{UR}{RR}\quad\frac{UU}{RR}\quad\frac{RR}{RU}\quad\frac{RU}{RU}\quad\frac{UR}{RU}\quad\frac{UU}{RU}$$

$$\frac{RR}{UR}\quad\frac{RU}{UR}\quad\frac{UR}{UR}\quad\frac{UU}{UR}\quad\frac{RR}{UU}\quad\frac{RU}{UU}\quad\frac{UR}{UU}\quad\frac{UU}{UU},$$

dividing the collection into 16 parts, although not quite evenly, owing to the far larger number of Radial Loops on the index fingers than on the middle. Each accumulation may now be broken up into 16 substantially equal parts, by the ridge count of both index and middle fingers, expressed by the signs — and +, as explained later. Each of these may then be divided by the ridge count of the right little finger; and any ordinary collection will then be broken up into sufficiently small groups to enable the one making the search to readily find any record that may be on file. Collections in the large Identification Bureaus may require further subdivision.

Following the method suggested below under the head of *Subdividing by Ridge Counting,* (*f*) where the thumb, index, and middle fingers of each hand are utilized, a collection of Radial and Ulnar Loops would first be subdivided into 16 groups by the $\frac{RR}{RU}$, etc., method, then each of these 16 groups subdivided by the $\frac{-+-}{+-+}$ etc., method, into 64 subdivisions, and finally subdivided again by the ridge count of the right little finger. Except in the case of very large collections, nothing further would be required.

(*e.*) *Subdividing by Ridge Tracing.* This is the method already explained for dividing Whorls into their three groups of Inside, Meeting, and Outside Whorls, by tracing the lower radiant proceeding from the left delta, and getting by that means its relationship to the delta of the opposite side.

In applying this to the purpose of classification only the index and middle fingers are used, and the method is thus applicable only to the sub-

division of those classes in which one or both of these fingers possess Whorls. Since the value of these particular Whorls is 8 + 4, any formula with a number between 5–16, and 21 – 32 would allow it. It is, however, of first importance in class $\frac{32}{32}$, where all the patterns are Whorls, and in those near this end of the series. Such groups are, among others,

$$\frac{13}{16}, \quad \frac{14}{15}, \quad \frac{14}{29}, \quad \frac{29}{32}, \quad \text{and} \quad \frac{30}{31}.$$

Using the usual symbols I, M, and O, for the three kinds of Whorls and for Composites that can be traced, we find the following combinations for a single hand:

II IM IO MI MM MO OI OM OO

These 9 combinations produce 81 separate groups when both hands are considered together.

(*f*) *Subdividing by Ridge Counting.* From the results obtained by counting the ridges of many hundreds of *Loops from index fingers* it is found that the average number falls between 9 and 10, so that if a quantity of index finger Loops were divided into two groups, one containing Loops with a ridge count of 1 – 9; the other one from 10 on, the two would be approximately equal. In the same way it has been ascertained that in *Loops from middle fingers* the average falls one point ahead, between 10 and 11, middle finger loops dividing equally as 1 – 10 and 11 on. This somewhat larger average for the middle finger is probably due to the fact that this finger is broader than the index.

If now, in both fingers, we represent the lesser group by —, and the greater by +, there will be the following 16 possible combinations of these groups:

$$\frac{-\,-}{-\,-}; \quad \frac{-\,+}{-\,-}; \quad \frac{+\,-}{-\,-}; \quad \frac{+\,+}{-\,-}; \quad \frac{-\,-}{-\,+}; \quad \frac{-\,+}{-\,+}; \quad \frac{+\,-}{-\,+}; \quad \frac{+\,+}{-\,+};$$

$$\frac{-\,-}{+\,-}; \quad \frac{-\,+}{+\,-}; \quad \frac{+\,-}{+\,-}; \quad \frac{+\,+}{+\,-}; \quad \frac{-\,-}{+\,+}; \quad \frac{-\,+}{+\,+}; \quad \frac{+\,-}{+\,+}; \quad \frac{+\,+}{+\,+}$$

These 16 subdivisions are applicable also to any classes involving Loops of either sort, Ulnar or Radial, on index and middle fingers. It is especially recommended for the following classes:

$$\frac{1}{3}\ \frac{1}{17}\ \frac{1}{19}\ \frac{3}{1}\ \frac{3}{3}\ \frac{3}{4}\ \frac{3}{19}\ \frac{4}{3}\ \frac{4}{4}\ \frac{17}{1}\ \frac{17}{3}\ \frac{17}{17}\ \frac{17}{19}\ \frac{19}{1}\ \frac{19}{3}\ \frac{19}{17}\ \frac{19}{19}\ \frac{19}{20}\ \frac{20}{3}\ \frac{20}{4}\ \frac{20}{19}\ \frac{20}{20}$$

and all combinations of these numbers.

In this form Henry and Seymour use letters instead of the — and + signs, I for — and O for +. Their subdivisions thus stand:

$\frac{II}{II}$; $\frac{IO}{II}$ $\frac{OI}{II}$; $\frac{OO}{II}$; $\frac{II}{IO}$; $\frac{IO}{IO}$; $\frac{OI}{IO}$; $\frac{OO}{IO}$;

$\frac{II}{OI}$; $\frac{IO}{OI}$; $\frac{OI}{OI}$; $\frac{OO}{OI}$; $\frac{II}{OO}$; $\frac{IO}{OO}$; $\frac{OI}{OO}$; $\frac{OO}{OO}$;

These have the decided disadvantage of being easily confused with the same letters when used to designate Inside and Outside Whorls, quite a distinct thing. Again the letters have here no meaning, as they stand for nothing, while the — and + easily suggest the larger and the smaller groups, on either side of a definite point.

By the counting of the ridges of the thumbs of many hundred male subjects, it is found that the average number on the right thumb falls between 16 and 17, and in the same way, the average falls one point behind in left thumbs, *i.e.*, between 15 and 16. As the records that were examined were all males, it is fair to assume that the count would be at least 2 ridges less in the case of females, and as an average count is desired for both thumbs, Loops with a ridge count of 1 to 14 can be represented by —, and a count of 15 on by +. Combining this with the — and + method for the index and middle fingers, we have combinations for the right hand as follows; — — —; — — +; — + +; — + —; + — +; + — —; + + —; + + +, in all 8. But as the same combinations can be made from the thumb, index, and middle fingers of the left hand (denominators), there are 8 x 8 combinations, 64 in all. Should letters be used to express the same, the combinations would be for the right hand (numerators) III IIO IOO IOI OIO OII OOI OOO, and the same for the left hand.

(*g*) *Subdividing by Arch Pattern Distribution.* This method has a special interest in being an attempt to get over a certain specific difficulty.

Like the majority of the methods of Secondary Classification, it developed from the need of finding some way of breaking up into smaller groups that large aggregation of prints that become filed away under the primary class $\frac{1}{1}$. When attempting to subdivide this class by index patterns only, using but two letters as a fraction, certain of the commonest of these subdivisions become in their turn so large and cumbersome that there is need of a subdivision of these, a sub-subdivision. For this purpose it was proposed that, aside from the two index patterns, which were sufficiently expressed by the capital, all the other Arches occurring on the two hands should be indicated by the small letter *a*, that for the thumb being placed at the left of the capital letter designating the index pattern, and those of the remaining fingers on the right. Instead of placing an *a* for each pattern, however, the number of such patterns was to be given,

followed by a single *a*. There thus resulted formulæ like the following, added to the class formula $\frac{1}{1}$.

$$\frac{\text{Aa}}{\text{aU2a}} \quad \frac{\text{aU2a}}{\text{Ua}} \quad \frac{\text{aR}}{\text{U}} \quad \frac{\text{Aa}}{\text{R2a}} \quad \frac{\text{U2a}}{\text{aUa}} \quad \frac{\text{Aa}}{\text{aU2a}}.$$

Not counting the letters involved in the original fraction, and indicating the patterns of the two index fingers, the Arch Combinations are 8 in number, as follows: The letter A is used to show the position of the index.

A	aA
Aa	aAa
A2a	aA2a
A3a	aA3a

But each one of the three patterns found in the class (A, R, U) may be used in the index place, thus giving 8 + 8 + 8, or 24, combinations for one hand. Multiplying this by itself in the usual way to get the combinations for two hands, we get 576, the number of subdivisions into which the $\frac{1}{1}$ class may be divided by this method. The difficulty here is that only about half of the $\frac{1}{1}$ class possess Arches, so that the plain formulæ, like $\frac{\text{R}}{\text{U}}$, or $\frac{\text{U}}{\text{U}}$, with no *a*'s added, will remain much overcrowded.

(*h*) *Subdividing by the Ridge Count of single fingers.* This method is always applied to the right little finger when it is a loop, for the subdivision of all aggregations, large or small. It might happen, however, that in some groups, a still further differentiation would be advisable. We could then make a subdivision of this small number by a *ridge count of the right thumb.* In a collection so large that the groups carried out to such detail might still be inconveniently numerous, the subdivision could pass in succession to all the other fingers, but in practice nothing has ever been needed beyond one more finger, *the left thumb.*

This long array of possible subdivisions, useful for the splitting up of the large and rather featureless class of $\frac{1}{1}$ would be the following:

I. Subdivision by the Arch combination, which eliminates about one half.

II. Subdivision of the remaining half of $\frac{1}{1}$ the class containing Radial and Ulnar Loops, by the $\frac{\text{RR}}{\text{RU}}$, etc. combinations, into 16 groups, each group further subdivided by the — and + combinations, and each group again subdivided by the ridge count of the right little finger.

III. Further subdivision of any of the 16 groups that is too large by means of the ridge count of the right thumb. This would divide a group to which it was applied into some 20 to 30 subdivisions.

IV. More than the above would be hardly necessary, even if the start were made with the prints of a million individuals, yet, if needed, there are plenty more applicable means of subdividing. Here the ridge count of the left thumb is suggested, beyond which no one has as yet had occasion even to suggest.

THE FILING OF FINGER-PRINT RECORDS: CARD CATALOGUES

The Writing of Formulæ. In writing out the formula with the ridge count of single fingers included, these latter appear as detached numbers, appended to the end (right side) of the fraction. Where one number alone is so given it is to be understood that it is the count of the right little finger; where there are two, the one on the left is this one and the fraction above and to the right, is that of the Arch Combination.

The following illustrate the appearance of the full formulæ for sets in the $\frac{1}{1}$ group, illustrating the application of the various methods:

$$(1)\quad \frac{1 \quad \mathrm{R\,U} \quad (-\ +) \qquad 12^{\left(\frac{1}{17}\right)}}{1 \quad \mathrm{a\ U\,U} \quad (+\ +)}$$

$$(2)\quad \frac{1 \quad \mathrm{a\ A\,U} \qquad\qquad 12^{\left(\frac{25}{29}\right)}}{1 \quad \mathrm{a\ A\,A}}$$

$$(3)\quad \frac{1 \quad \mathrm{R\,U} \quad (+\ -) \qquad 7}{1 \quad \mathrm{U\,R} \quad (+\ +)}$$

$$(4)\quad \frac{1 \quad \mathrm{U\,U} \quad (+\ +) \qquad 8}{1 \quad \mathrm{U\,U} \quad (-\ -)}$$

These are for use in a very large collection:

$$(5)\quad \frac{1 \quad \mathrm{U\,U} \quad (-\ +\ +) \qquad 15}{1 \quad \mathrm{R\,U} \quad (+\ -\ +)}$$

$$(6)\quad \frac{1 \quad \mathrm{a\ U\,A} \quad (-) \qquad \mathrm{a}^{\ \frac{22}{5})}}{1 \quad \mathrm{U\,A} \quad (+)}$$

In the first (1) the presence of an *a* before the U indicates the position in which it stands, an Arch on the left thumb. As there are no others in the formula it shows that there are no other Arches present; it indicates also, that the small fractions at the end refers to the Arch Combination, the value of which, 16 + 1, for the denominator, also indicates an Arch on the left thumb. The signs in parentheses indicate the ridge count, whether more or less than the average, on index and middle fingers, and the figure 12, above the line, shows the exact ridge count of the right little finger.

Formula Number 2 is similar, but indicates the presence of more Arches. The single *a* in the denominator indicates an Arch on the left thumb, the capital letters AA indicate Arches on the left index and left middle fingers, and is precisely indicated by the small fraction at the end, which gives the value 29 for the left-hand Arches. From this subtract the usual 1, making 28; then the 16, 8, and 4, indicating an Arch on the thumb, index, and middle fingers of the left hand.

In (5) the signs in parentheses indicate the ridge count whether more or less than the average, on thumb, index, and middle fingers.

In (6) the signs in parentheses indicate that both index fingers are Loops, the *a* in the place of the ridge count of the right little finger, indicates an Arch on that finger, and that is also indicated by the numerator of the fraction that indicates the Arch Combination $\left(\frac{22}{5}\right)$, which can only be made from 16 + 4 + 1, which with 1 added make 22. Many do not put the *a* at the end, but the authors believe that the formula of a finger-print record should be reasonably complete, without being crowded to the extent of being confusing.

In other classes besides the $\frac{1}{1}$ the subclassification need not be so long and complicated, since the number of individual sets to be classified is not nearly so numerous. Thus, for many cases an entire formula may include but a single method of secondary classification:

$$(7)\qquad \frac{13 \quad \mathrm{MM} \quad 13}{16 \quad \mathrm{IO} \qquad\quad}$$

$$(8)\qquad \frac{32 \quad \mathrm{IO} \quad 0}{32 \quad \mathrm{MI} \qquad}$$

$$(9)\qquad \frac{25 \quad \mathrm{IU} \quad (\ \ -)}{17 \quad \mathrm{UR} \quad (-\ +)}\ 7$$

Numbers 7 and 8 show the classification of Whorls, where both index and middle fingers of both hands possess them. In (9) there is but a single Whorl on these fingers, and two other types, as is indicated by the letters R and U. The letter I fixes the position of the single Whorl involved, and describes it at the same time. The next following fraction, $\left(\frac{-}{-\ +}\right)$ indicates the ridge-count combinations of the Loops.

Classification in the case of damaged or missing fingers. In cases of missing fingers, or where, through scars or otherwise a satisfactory print cannot be taken, the corresponding space on the record card is filled in, with the abbreviation *amput* (amputated) or *def* (defective), as the case may be. In such cases the corresponding finger of the other hand is used for classification. If the same digit is wanting or defective on both hands, the pattern is called a Meeting Whorl, and the record is classified accordingly. The absence of even more than two digits does not prevent classification.*

Subjects with only one hand may be kept in a file by themselves, and with these may be included the rare cases with extra digits, such as two thumbs or five fingers and a thumb. In an ordinary collection these would

*Where a digit is damaged to such an extent that the pattern cannot be determined, the print is classified as if the finger were missing entirely; but in prints where there are scars not serious enough to cause doubt as to the nature of the pattern, no attention is paid to the scar. Where there are short creases, generally the result of age, no attention is paid to them in classifying.

be so few as to render any subclassification unnecessary. When this accumulation becomes too large for convenience, an applicable system could be readily devised, based upon the usual methods, which would prove satisfactory. In cases of major defects of both hands, involving all the fingers, it would be easily possible to use the soles, employing the system described above.

Method of Search. The usual occasion for employing a classified finger-print file is to find the duplicate of either a set of prints handed over for the purpose, or of the finger patterns of some person actually under inspection. The request may come in the form of a written formula on a card, or of an actual set of prints. As the formula is the real point of departure needed in order to find a given set, when the request is given in the form of actual prints, these are to be at once formulated, and the latter employed for the purpose. When a certain card, or a small package of very similar cards, has been found in the collection, the detailed comparison is to be made, print for print, but all handling of the collection as a whole should be by formula.

The method of effecting this is best shown by an example. Suppose the following card is given in at headquarters, with the request to find whether it is in the collection or not, and if so to bring it out for comparison:

$$\frac{19 \quad \text{U U} \quad (-\ +) \quad 14}{19 \quad \text{R U} \quad (-\ +) \qquad}$$

The expert in charge goes at once to Drawer Number 19, and takes from it the 19th of the 32 folders. From the subdivisions of this, he selects that labelled $\frac{\text{UU}}{\text{RU}}$. This is found divided into 16 divisions, bearing the various combinations of signs, and selects the combination $(\frac{-+}{-+})$. Even though the entire collection number hundreds of thousands, there would be expected only a small group here, perhaps fewer than 30, where it would not be a long matter to look over each card individually to compare with the sample prints; but in this case the formula gives a further specification which renders even this amount of comparison unnecessary, and states the exact ridge count of the right little finger, 14. Out of the lot there may be two, or even three, which correspond even this far, and these are finally taken from the cabinet. The final selection must then be made by comparing the actual prints of the individual sought, with this small number, and the decision can usually be reached in a moment. Usually, with so complete a formula, there would be no need of this final comparison, for with the ridge count the formula would definitely point to one individual record, and only one; but in any case, the formula in question would be almost as readily found as a word in a dictionary or a name in a directory.

If a given formula cannot be found, it would probably mean that the

prints of the individual desired were not in the collection; yet it would be well to look for all possible errors in formulating or filing, and continue the search among closely related formulæ, as would be done in a directory in the case of surnames with more than one usual spelling. Thus always, in a ridge count, a limit of error of 2 is allowed on either side, and in finding 14, as here, the cards from 12 to 16 are included in the search. (In some bureaus a ridge count of 3 on either side has been adopted.)

Filing the Finger-Print Cards in a Collection. In the matter of filing the finger-print cards the limits of this chapter prevent any extended explanation. When a collection is small it may be filed by the primaries only, subdividing later, as the separate classes become individually large enough to render it advisable. The various smaller subdivisions are also to be added according to need, and in the accumulations that require it, so that in a collection of moderate size it would be quite possible to find some of the 32 primary classes divided and subdivided to the ridge count, while others remain undivided.

Guide cards for the various methods of subdivision may be made to order, according to requirement. As for the record cards themselves nearly all the police departments in the country employ one 8 inches square, but the United States Government has a special size, 8 inches high and 7 inches wide. The first slips used were of paper, about 13 inches long and 8½ inches wide. Instead of filing vertically, as is now universal, they were laid flat.

The card, which combines the data of the older identification card with the finger prints, must in all cases be large enough to contain the following:

1. Name and aliases, nationality, criminal specialty, etc.
2. The two Bertillon photographs, front and side.
3. The Bertillon measurements, with some data concerning eyes, hair, and facial features.
4. The ten finger prints.
5. The formula for the same.
6. Bodily marks, scars, tattooing, etc.
7. Criminal history.

Since both sides of a card are available, all the above can be brought within a small compass without crowding, and, in a large collection, a reduction of the size of the card is a manifest advantage. The authors find that a card 6 x 6 inches answers very well, and has been used for some years with excellent results. It accommodates data 1 – 5 on one side, and leaves plenty of room for data 6 and 7 upon the other (Figure 84). The "plain" or "dab," impressions — that is, the four fingers held to-

gether, and printed at one stroke — are omitted, as their advantage is not considered great enough to compensate for the room they occupy. Greater care while taking the prints, always putting each finger in the proper place, will obviate the necessity of depending on such prints for the order of the fingers, and saves much space in the files.

FIGURE 84. Identification card measuring 6 x 6 inches, as used by the authors. The finger prints are wholly upon the front, with the photographs and Bertillon measurements. Upon the backside are name, aliases and other data, the bodily marks and the criminal history. Plain impressions (four fingers together, not rolled) are omitted. The above illustration reduced ¼.

The vertical system of filing is undoubtedly the best and cheapest method. For this the drawers should have inside dimensions a little greater than that of the cards, yet not enough to allow the cards to slip out of alignment and look disorderly. For the usual 8 x 8 cards, with guide cards standing up above the rest some half inch or so, the drawers should

have a depth of perhaps 9 or 9½ inches, and a width of 8½ inches. They should always be provided with adjustable sliding boards to stand back of the cards and keep them held upright, whether many or few.

A small collection can be well accommodated in a cabinet of 32 such drawers, and the 32 subdivisions of each drawer can be made by guide cards, projecting a little above the level of the rest. The drawers might bear on the outside the numbers for the denominators, the left-hand formulæ, and the guide cards within those of the numerators, the right-hand formulæ. In a growing collection the first pinch is naturally felt in the $\frac{1}{1}$ class, and a second special cabinet of some form might be arranged for the expansion of this class, leaving the original cabinet for the other 31 formulæ, for which it would probably be sufficient for some time to come.

In all cases, whether the original accommodations be ample or restricted, it saves time in the end if the formulation of each card entered be made as complete as if intended for a place in a filing cabinet for a million cards. Since, in a rapidly growing collection, the accumulation of the $\frac{1}{1}$ class is to be expected, the full formulation of each, with the ridge count for each finger, should be carefully made out for each card before filing. This will not only be of great use in expanding the collection, but will allow the sending of the formula at any instant to a larger bureau, which would require the additional data.

When transitional patterns are met with, where there may be some doubt as to the type to which it may be assigned, it is a good plan to mark it with a question mark after the first decision is made, and then lay it aside for a day or so. It may then be examined anew, either by the same operator or by another, and, if the same conclusion is reached, it may be filed.

Before filing any finger-print card an alphabetical index card should be made of the same subject, bearing name and formula. These cards should be placed in a card index of the usual types, filed by the name, alphabetically, thus:

Doe, John (alias Richard Roe), $\dfrac{1 \quad \text{U R} \quad (-\,+) \qquad 12}{17 \quad \text{U U} \quad (+\,-)}$

Cards should also be made out for each alias, with the formula, referring to the original name, and included in the same index, thus:

Roe, Richard (alias for John Doe), $\dfrac{1 \quad \text{U R} \quad (-\,+) \qquad 12}{17 \quad \text{U U} \quad (+\,-)}$.

Such an index furnishes the immediate answer to such questions as the following:

1. What is the finger-print formula for John Doe?
2. We have detained here a man, suspected of being Samuel Jones, wanted for the Robinson burglary at X———. Has your bureau his finger prints, and if so, what are they?

Without the name index to supplement the index of finger prints these questions must remain unanswered; with it, the reply can be sent immediately.

Sometimes, especially in the identification of chance impressions, the print of a single finger only is known, and, unless additional data are obtained, limiting the search to the finger patterns of a few suspected parties, the case is practically hopeless. This difficulty has been removed at the police headquarters at Madrid, Spain, since the prefect of that city, Señor Oloriz, has established there an index for the separate fingers of those whose records are contained in their files. He can thus, by the help of this special index, turn to a given finger print, and find it with nearly the same readiness that can be done with the usual collection of complete sets. This would be an ideal method to establish in all our cities, especially for records of the criminal classes, where frequently the identification of a single print comes to consideration.

In presenting this chapter, which is intended to serve as a practical working Manual of the Finger-Print System, as used at present, the authors wish to express the debt of gratitude the entire world owes to that trio of illustrious Englishmen, Sir William Herschel, Sir Francis Galton, and Sir Edward Richard Henry. Each of these in order did his part in the development of this great System of Personal Identification, and assisted in bringing it to its present degree of usefulness. Especially do the authors wish to express their admiration for the genius of the last named, the honored chief of New Scotland Yard, who put the system into actual use. The world owes to him a debt of gratitude, not only for what has been made possible in its present restricted field of police circles, but also for rendering possible the broader applications which are bound soon to develop in families, in cities, in commonwealths, and perhaps in the nation.

CHAPTER VI

FINGER PRINTS: THE CODE

"We had a Rabbinical Divine in England, who was Chaplain to the Earl of Essex in Queen Elizabeth's time, that had an admirable head for Secrets of this Nature. Upon his taking the Doctor of Divinity's Degree, he preached before the University of Cambridge, upon the first Verse of the first Chapter of the first Book of Chronicles, in which, says he, you will see the three following words: 'Adam; Sheth; Enoch.' He divided this short Text into many Parts, and by discovering several Mysteries in each word, made a most learned and elaborate Discourse." — Joseph Addison; in the London Spectator, No. 221. Nov. 13, 1711.

IN the year 1911 one of the authors had occasion to call up the Police Department in a distant city about a person under arrest. This individual had given a name that was thought to be false, and his correct name and criminal history were desired. The details of the imprints from his ten fingers were given in order, beginning with the right thumb and ending with the left little finger, and the personal description, including age, height, weight, color of hair and eyes, was also given. In a very short time the correct name and history of the man were telephoned back.

A similar incident took place on Monday, August 30, 1915, when Lieutenant Damery of the Somerville (Massachusetts) Police Department telephoned Mr. R. C. Hill, in charge of the Bureau of Identification at the State House, Boston, Massachusetts, about a man arrested in Somerville the Saturday before. Lieutenant Damery telephoned the details of the prints from the ten fingers of the arrested man, and in a few minutes Mr. Hill telephoned back the name and history of the suspect. In this short time, with nothing but a brief description of the finger prints for identification, the card of this particular man had been selected from the thousands on file.

These two incidents, although perhaps no longer rare, may be considered as practical demonstrations of what can be done, in the absence of the actual prints by two persons having a common understanding. The main difficulty consists of the methods of describing the separate prints, since (1) each expert might use his own language, and thus cause frequent misunderstandings, and (2) the number of words employed would be large. This latter difficulty would be of little significance when using

the telephone, but, from its cost, would render the telegraph, often a much better medium of communication, often prohibitive.

Here, however, a suggestion comes from the extensive employment of codes, especially in transatlantic messages, where, by means of duplicate lists in the possession of both sender and receiver, a single meaningless word may have the value of an entire phrase or sentence. If, in the case under consideration, a single code word could express a special type and variety of finger pattern, the ten words employed to describe an entire set of finger prints would come precisely within the limit of the minimum telegraph rate. Where the same description needs to be sent to several diffierent places at the same time, the telegraph, used with such a code, would have great advantages over the telephone in every way, saving time, money, and labor.

Such a code, for describing finger prints, is given, in what will probably prove to be sufficient detail, in the present chapter; and to it are added codes for general description, including the Bertillon measurements for every millimeter within probable limits. Already subjected to a limited number of practical trials, they seem to be entirely satisfactory; and even though a more extended use may very likely suggest some modifications, they will probably not be very extensive. At any rate the only proof to which such a system can be subjected is the practical one of actual trial. The authors offer this code with the hope that it may prove of real value to the world.

To explain the workings of the code, we may take first the matter of the finger prints alone. These are taken in the customary order:

Rt. Thumb; Rt. Index; Rt. Middle; Rt. Ring; Rt. Little.
Lft. Thumb; Lft. Index; Lft. Middle; Lft. Ring; Lft. Little.

A sample message, giving the finger prints of a suspect, may be as follows:

Wordy	Ladle	Upright	Wagon	When
Travel	Arbor	Celery	Always	Ruddy

The recipient of this message would then turn to his code, which he would use like a dictionary, and in a few minutes would have it translated, thus:

Wordy: An Elongated Whorl; inside tracing by 17 ridges.
Ladle: A Lateral-Pocket Loop; inside tracing by 10 ridges.
Upright: An Ulnar Loop with a count of 15 ridges; approximating a central pocket.
Wagon: A Whorl; inside tracing by 13 ridges.
When: A Whorl; outside tracing by 12 ridges.

Travel: A Twin-Loop; outside tracing by 12 ridges.
Arbor: A Tented Arch.

Celery: A Central-Pocket Loop; tracing, a meeting, having 2 ridges inside.
Always: An Inside Accidental. The sender cannot tell the ridge count.
Ruddy: A Radial Loop, with a count of 13 ridges; the pattern resembles the "Invaded Loop" of Galton.

From this specification, thus expanded, the recipient may easily write out the classification formula, which is $\frac{28 \quad \mathrm{IU} \quad o}{23 \quad \mathrm{AM}}$ Such an unusual combination would require nothing more.

For an ordinary case, where, for instance, the patterns were all Ulnar Loops, we might have the following:

Uncap	Unclad	Unclose	Uncutx	Unbend
Uncivil	Under	Undone	Unclean	Unarm

All of these words will be found in the code listed under Ulnar Loops, and express the different ridge counts of this common pattern.

The translation of this message is as follows:

Uncap: Ulnar Loop; ridge count 6.
Unclad: Ulnar Loop; ridge count 8.
Unclose: Ulnar Loop; ridge count 11.
Uncutx: Ulnar Loop; ridge count 14; a scar on the pattern. not sufficient to obliterate it.
Unbend: Ulnar Loop; ridge count 5.

Uncivil: Ulnar Loop; ridge count 7.
Under: Ulnar Loop; ridge count 15.
Undone: Ulnar Loop; ridge count 17.
Unclean: Ulnar Loop; ridge count 10.
Unarm: Ulnar Loop; ridge count 3.

The letter x, seen here added to the word Uncut, the code word for the right ring finger, may be added to any of the code words signifying finger patterns, and signifies the presence of a scar or injury, more or less noticeable, but not sufficient to destroy the pattern, or prevent its reading. It makes no sense, and often renders the word unpronouncable, but in reading the word aloud, it can be pronounced as usual, adding the x to it as a separate syllable. In using this, too small scars should be ignored, and the recipient should bear in mind that any scar indicated might have been acquired subsequent to the taking of the prints he may have on file.

The code for the age, height, weight, Bertillon measurements, etc., is to be used in the same way as that for the finger prints. The sender, who has the expanded data, probably derived at first hand from a suspect, translates them into the language of the code, and sends that to the recipient, who translates the message back into its expanded form.

As an illustration, the following code telegram, received at headquarters at X——, contains the finger prints and full description, including the Bertillon measurements, of a certain safe-blower. It consists of 25 words, but expands to 163.

Whelm	Wharf	Wharf	Wedge	Wheeze
Usure	Wader	Wader	Wabble	Water
Yate	Odd	Ideate	Jest	Neigh
Harem	Heir	Darling	Farrier	Giggle
Menace	Defix	Berlin	Slice	Echo

Of this telegram, the first ten words give the finger prints. There are always ten of these, for when a finger is missing its place is kept by the use of the code word ABSENT. The next five words, in the order given, signify: age, weight, eye color, hair color, shape of nose. Then follow the full ten Bertillon measurements.

The translation of the above is as follows:

Finger Prints.

Rt. Thumb. Outside Whorl by 10 ridges.
Rt. Index. Outside Whorl by 5 ridges.
Rt. Middle. Outside Whorl by 5 ridges.
Rt. Ring. Meeting Whorl, having 2 ridges inside.
Rt. Little. Outside Whorl by 9 ridges.
Lft. Thumb. Ulnar Loop, invaded type of Galton; count of 16 ridges.
Lft. Index. Inside Whorl by 6 ridges.
Lft. Middle. Inside Whorl by 6 ridges.
Lft. Ring. Inside Whorl by 3 ridges.
Lft. Little. Inside Whorl by 7 ridges.
Age, thirty-six years.
Weight, one hundred and seventy pounds.
Color of Eyes, slate blue.

Color of Hair, dark chestnut.	Lft. forearm, 47.6.
Nose, ridge straight; base horizontal.	Total height, 1.68.5.
Head length, 20.0.	Lft. lit. fin., 9.1.
Head width, 16.1.	Ht. trunk, 87.6.
Lft. mid. fin., 11.9.	Arm reach, 1.79.0.
Lft. foot, 26.2.	Length rt. ear, 6.1.

While a rigid order is necessary for the ten finger patterns, no harm would be done by sending the Bertillon measurements or the personal description in any other order, or in mixing them up completely, as there are no duplicate words used in the code, and each word, when found, shows by its place in the code what its meaning is. Footnotes on the code tables for the finger prints direct the user what to do in case a delta is missing, and either the count or the tracing, or both, cannot be ascertained. In the case of whorls the tracing, though not the ridge count, may sometimes be learned in the absence of one of the deltas, as explained in Chapter VI. There is also a place in the code for fingers variously damaged, or lost, with the heading, *Injured and Missing*.

In the tables for the Bertillon heights the equivalents for the even inches are given in a distinct type, to aid in the comparison between the

metric and English measures. Any fraction between the even inches may be readily found also, as a millimeter is almost exactly 1/25th of an inch. To illustrate, if the height of a given subject was 5 feet 8½ inches, the word selected would be MIRE; that is, a code word about halfway between the place for 5 feet 8 inches and 5 feet 9 inches. As a reminder, it may be noted that all heights must be taken in bare feet, as with shoes there would be an addition of about one inch.

In the tables for eye color there are two separate lists presented: one for the colors as usually spoken of by the average person and one to correspond with the more precise Bertillon chart, that gives the numerous grades as used by the French method. There will be no confusion in using either, as there are no duplicate words.

Aside from the manifest advantages of a code for the purpose of shortening messages, the substitution of words for formulæ is often more exact. One of the authors once visited one of the largest and best-conducted identification bureaus in the country, where he was shown an accumulation of 23 records that were filed under exactly the same classification formula. At a later visit the experiment was tried with four of these records of substituting the code words for the classification formula, and the results were all different; as well differentiated as though filed under different formulæ. Although a classification formula alone, or the Bertillon measurements alone, are not expected to establish certain identity in the absence of other information, it is reasonable to suppose that in 99 per cent of the cases the Finger Print and Bertillon codes will do it, although the actual prints are absent. This naturally supposes complete accuracy on the part of the officer putting the prints into the code, as well as on the part of the one who receives the message, as the first must be absolutely accurate in his analysis, and must send the words in the correct order. In the rare case where all of the ten finger patterns are arches there is no chance for differentiation between two such records, but in such cases it may reasonably be expected that among the patterns there would be some that approximate other types, and in any case the Bertillon measurements and the personal description should form a sufficient differentiation between the two individuals.

Still another advantage that comes from the use of the code is the ease by which a worker learns the individual types of patterns by associating them with their code words. It is like giving names, rather than descriptions, to a large number of any similar objects; they acquire thereby a certain individuality, and are readily remembered and recognized whenever met with. The use of a code is too new yet to prove this probable worth of it, but it will undoubtedly be shown by practical experience. The patterns shown in Chapter VI are designated by both description and code word, and the reader will soon come to know the separate figures

there shown by their code names, and think of them afterwards by them.

In the code, which follows immediately, the types of patterns are arranged alphabetically, and the separate patterns under each are arranged, so far as possible, with the number of ridges in numerical order. In such lists the code words are also alphabetical, to be more readily found when translating a message.

ACCIDENTALS

Inside Tracing		Outside Tracing		Tracing That Meets	
Ridges	*Code*	*Ridges*	*Code*	*Ridges*	*Code*
3	Alack	3	Ancient	None	Aid
4	Aland	4	Ancome	1 inside	Ail
5	Alarm	5	And	2 inside	Aim
6	Alas	6	Andiron	1 outside	Air
7	Albin	7	Anear	2 outside	Airy
8	Album	8	Anemone		
9	Alcohol	9	Anent		
10	Alcove (Pl. V, *a*)	10	Angel		
11	Ale	11	Anger		
12	Alga	12	Angina		
13	Algebra	13	Angle		
14	Alien	14	Anguish		
15	Alive	15	Aniline		
16	Alight	16	Animal		
17	Align	17	Animate		
18	Alike	18	Anise		
19	Alley	19	Ankle		
20	Alloy	20	Anneal		
21	Allure	21	Annoy		
22	Ally	22	Annual		
23	Almanac	23	Anode		
24	Almond	24	Anoint		
25	Alms	25	Anon		
26	Aloe	26	Ant		
27	Alone	27	Antelope		
28	Aloof	28	Antic		
29	Aloud	29	Anthem		
30	Alps	30	Anthrax		
31	Alpine	31	Antimony		
32	Alter	32	Antique		
33	Alto	33	Antler		
34	Alum	34	Anvil		
35	Alvine	35	Anxious		
	ALWAYS		ANY		

ARCHES

	Code
Arch	Arch (Pl. I, *a*)
Arch app. Ulna	Abed
Arch app. Radial	Able (Fig. 57)

TENTED ARCHES

Tent	Arbor (Pl. I, *b*)
Tent app. Ulna	Armor (Pl. I, *c*)
Tent app. Radial	Arrange

INJURED AND MISSING, ETC.

	Code
Ulnar, injured but can be recognized	Damaged
Radial, injured but can be recognized	Disabled
Whorl, injured but can be recognized	Disfigured
Arch, injured but can be recognized	Destroyed
Amputated	Absent
Cannot be classified easily, for any reason.	Nondescript

If the ridges of Accidentals cannot be counted, use the code word ALWAYS for Inside Tracings, and the code word ANY for Outside Tracings. Where neither count nor tracing can be ascertained, use the code word ACCIDENTAL. In such cases the remaining nine words will find the duplicate.

CENTRAL POCKET LOOPS No. 1.

Typical Central Pockets (Inside)		Typical Central Pockets (Outside)		Approx. Ulnars (Inside)		Approx. Ulnars (Outside)	
Ridges	*Code*	*Ridges*	*Code*	*Ridges*	*Code*	*Ridges*	*Code*
3	Cab	3	Chain	3	Clad	3	Coach
4	Cabin	4	Chair	4	Claim	4	Coal
5	Cable	5	Chaise	5	Clam	5	Coarse
6	Cad	6	Chalk	6	Clamp	6	Coast
7	Cadet	7	Chance	7	Clan (Pl. IV, *e*)	7	Coat
8	Cage	8	Change	8	Clang	8	Cob
9	Cake	9	Chant	9	Clap	9	Cock
10	Calf	10	Chap	10	Claret	10	Cod
11	Calico (Pl. IV, *b*)	11	Char (Pl. IV, *a*)	11	Clash	11	Cog
12	Calif	12	Charm	12	Clasp	12	Coil
13	Calk	13	Chart	13	Class	13	Coin
14	Call	14	Chase	14	Clause	14	Coke
15	Calm	15	Chat	15	Claw (Pl. II, *f*)	15	Cold
16	Caloric	16	Chan	16	Clay	16	Colon
17	Calp	17	Cheap	17	Clean	17	Color
18	Calyx	18	Cheek	18	Clear	18	Colt
19	Cam	19	Cherry	19	Cleave	19	Comb
20	Came	20	Chess	20	Cleft	20	Comet
21	Camel	21	Cheval	21	Clerk	21	Comma
22	Cameo	22	Chew	22	Clew	22	Compose
23	Camp	23	Chick	23	Click	23	Con
24	Camphor	24	Chide	24	Cliff	24	Condor
25	Can	25	Chime	25	Clime	25	Confer
26	Canal	26	Chip	26	Clog	26	Consult
27	Caneer	27	Choke	27	Cloak	27	Content
28	Candle	28	Chop	28	Clod	28	Cook
29	Candor	29	Chuck	29	Clock	29	Cool
30	Candy	30	Church	30	Close	30	Coop
31	Cane	31	Churl	31	Clot	31	Copal
	CANT		CHURN		CLOWN		COPY

Typical Central Pockets Meeting		Approx. Ulnars Meeting	
Ridges	*Code*	*Ridges*	*Code*
None	Cease	None	Cider
1 inside	Cedar	1 inside	Cigar
2 inside	Celery	2 inside	Cinder
1 outside	Celt	1 outside	Circle
2 outside	Cent	2 outside	Civil

CENTRAL POCKET LOOPS (*Continued*)

Approx. Radials (Inside)		Approx. Radials (Outside)		Approx. Radials (Meeting)	
Ridges	*Code*	*Ridges*	*Code*	*Ridges*	*Code*
3	Crab	3	Cube	None	Cycle
4	Crack	4	Cubit	1 inside	Cygnet
5	Craft	5	Cuckoo	2 inside	Cymbal
6	Crag	6	Cud		
7	Cramp	7	Cudgel	1 outside	Cynic
8	Crane	8	Cue	2 outside	Cypress
9	Crank	9	Cuff		
10	Crape	10	Cull		
11	Crash	11	Culm		
12	Crate	12	Cumber		
13	Crave	13	Cup		
14	Craw	14	Cupid		
15	Crawl	15	Curb		
16	Craze	16	Cure		
17	Creak	17	Curfew		
18	Cream	18	Curl		
19	Crease	19	Currant		
20	Credit	20	Curry		
21	Creed	21	Curse		
22	Creep	22	Curt		
23	Crest	23	Curtain		
24	Crib	24	Curve		
25	Crisp	25	Cushion		
26	Crock	26	Custard		
27	Crops	27	Custom		
28	Cross	28	Cut		
29	Crow	29	Cute		
30	Crude	30	Cutlass		
31	Crumb	31	Cutlet		
	CRUSH		CUTWORM		

If the ridges of a Central Pocket cannot be counted, use the word CAN'T for ordinary Central Pockets, with inside tracing, and the word CHURN if the tracing is outside. If the Central Pocket approximates an Ulnar Loop with the tracing inside, use the word CLOWN, and the word COPY if the tracing is outside. If the Central Pocket approximates a Radial Loop with the tracing inside, use the word CRUSH, and the word CUTWORM if the tracing is outside. If neither counting nor tracing can be ascertained, use the code word CENTRAL; the remaining nine code words will find the duplicate.

LATERAL POCKET LOOPS

Inside		Meeting		Outside	
Ridges	*Code*	*Ridges*	*Code*	*Ridges*	*Code*
3	Label	None	Lead	3	Lick
4	Labor	1 inside	Leak	4	Lid
5	Lace	2 inside	Level	5	Life
6	Laconic			6	Lift
7	Lad	1 outside	Lever	7	Light
8	Ladder	2 outside	Lewd	8	Lilac
9	Lade			9	Lily
10	Ladle			10	Limb
11	Lady (Pl. V, *d*)			11	Limber
12	Lag			12	Limbo
13	Lake			13	Lime (Pl. V, *b*)
14	Lamb			14	Limit
15	Lame			15	Limp
16	Lance			16	Line
17	Land			17	Link
18	Lane			18	Lint
19	Lank			19	Lip
20	Lap			20	Liquid
21	Lapel			21	Lisp
22	Lapse			22	Listed
23	Lard			23	Live
24	Lark			24	Liver
25	Lash			25	Load
26	Lass			26	Loam
27	Last			27	Local
28	Latch			28	Lock
29	Late			29	Locust
30	Lath			30	Lodge
31	Laud			31	Loft
32	Laugh			32	Log
33	Launch			33	Logic
34	Laurel			34	Loin
35	Lava			35	Long
6	Lavish			36	Look
37	Lawn			37	Lope
38	Lay			38	Lord
39	Layman			39	Lore
	LAZE				LOST

If the ridges of Lateral Pockets cannot be counted, use the word LAZE in the case of Inside Lateral Pockets; and the word LOST in the case of Outside Lateral Pockets. If neither counting nor tracing can be determined, use the word LATERAL; the remaining nine code words will find the duplicate.

RADIAL LOOPS

Typical Radials		Invaded Radials		Approx. C. P.		Approx. Arches	
Ridges	*Code*	*Ridges*	*Code*	*Ridges*	*Code*	*Ridges*	*Code*
1	Rabid	1	Rub	1	Reach	1	Rib (Pl. I, *d*)
2	Race	2	Rubble	2	Read	2	Rice
3	Rack	3	Rubbish	3	Real	3	Rich
4	Racket	4	Rubicon	4	Reap	4	Ride
5	Racy	5	Rubify	5	Rear	5	Rife
6	Radical	6	Rubric	6	Rebel	6	Rig
7	Radish	7	Ruby	7	Reck	7	Rill
8	Raffle	8	Ruck	8	Recoil	8	Rind
9	Raft	9	Rud	9	Record	9	Ripe
10	Rag	10	Rudder	10	Rectify	10	Rise
11	Rage	11	Ruddle	11	Reduce	11	Risk
12	Ragged	12	Ruddock	12	Reed	12	Risking
13	Raging	13	Ruddy	13	Reef	13	Rival
14	Raid	14	Rude	14	Reek	14	Rive
15	Rail	15	Rue	15	Reel	15	River
16	Rain	16	Ruff	16	Reeve	16	Rivet
17	Raise	17	Ruffle	17	Refer		
18	Rake	18	Rufous	18	Refit		
19	Rally	19	Rug	19	Refuse		
20	Ram	20	Rugin	20	Relax		
21	Ramble	21	Ruin	21	Remit		
22	Ramp	22	Ruminate	22	Remove		
23	Ramrod	23	Ruinous	23	Rend		
24	Ran	24	Rule	24	Renew	Approx. Tents	
25	Rancid	25	Ruler	25	Rent	*Ridges*	*Code*
26	Random	26	Ruly	26	Repel		
27	Range	27	Rum	27	Rescue	1	Road
28	Rank	28	Rumor	28	Reset	2	Roam
29	Ransom	29	Rump	29	Resin	3	Roar
30	Rant	30	Run	30	Resort	4	Roast
31	Rap	31	Rung	31	Rest	5	Robe
32	Rapid	32	Runt	32	Revel	6	Robin
33	Rare	33	Rupee	33	Revenge	7	Rock
34	Rash	34	Rural	34	Reverb	8	Rod
35	Rat	35	Ruse	35	Revere	9	Roe
36	Rate	36	Russ	36	Reverse	10	Roll
37	Ratio	37	Rust	37	Revert	11	Romp
38	Rave	38	Rustic	38	Review	12	Roof
39	Ravel	39	Rut	39	Revile	13	Room
40	Raw	40	Ruth	40	Revise	14	Root
41	Raze	41	Rutil	41	Revive	15	Rope
42	Razor	42	Rutter	42	Revoke	16	Rose

If the ridges of Radial Loops cannot be counted for any reason, use the word RADIAL; the remaining nine code words will find the duplicate.

TWIN-LOOPS

Inside		Meeting		Outside	
Ridges	*Code*	*Ridges*	*Code*	*Ridges*	*Code*
3	Tab	None	Than	3	Trace
4	Tabby			4	Track (Pl. V, *e*)
5	Table	1 inside	Theme	5	Trade
6	Tabor	2 inside	There	6	Traffic
7	Tack			7	Trail
8	Tail	1 outside	Thick	8	Tram
9	Taint	2 outside	Thing	9	Trance
10	Take			10	Trap
11	Talk			11	Trash
12	Tame			12	Travel
13	Tang			13	Tray
14	Tape			14	Tread
15	Taper			15	Treat
16	Tar			16	Treble
17	Tardy			17	Tree
18	Tart			18	Tremor
19	Task			19	Trench
20	Taste			20	Tribe
21	Tasty			21	Trick
22	Taunt			22	Trig
23	Taut			23	Trill
24	Tea			24	Trim
25	Teach			25	Trio
26	Team			26	Trip
27	Tear			27	Triple
28	Tease			28	Tripod
29	Teat			29	Trite
30	Teem			30	Trod
31	Teeth			31	Troop
32	Tell			32	Trophy
33	Temper			33	Tropic
34	Tempest			34	Trot
35	Temple			35	Troth
36	Tempt			36	Trough
37	Tenant			37	Trowel
38	Tend			38	Truce
39	Tender			39	Truck
	TENURE				TRUE

If the ridges of Twin-Loops cannot be counted, use the word TENURE in the case of Inside Twin-Loops; and the word TRUE in the case of Outside Twin-Loops. Where neither the count nor tracing can be ascertained, use the code word TWIN; the remaining nine words will find the duplicate.

ULNAR LOOPS

Typical Ulnars		Invaded Ulnars		Approx. C. P.		Approx. Arches	
Ridges	*Code*	*Ridges*	*Code*	*Ridges*	*Code*	*Ridges*	*Code*
1	Unable	1	Us	1	Upbear	1	Ulans
2	Unapt	2	Usable	2	Upcast	2	Ulcer
3	Unarm	3	Usage	3	Uphill	3	Ulcerated
4	Unbar	4	Usance	4	Uphold	4	Ulcered
5	Unbend	5	Use	5	Upland	5	Ulema
6(Pl.I,*f*)	Uncap	6	Used	6(Pl.II,*d*)	Upled	6	Uletree
7	Uncivil	7	Useful	7	Uplift	7	Ullage
8	Unclad	8	Useless	8	Uplook	8	Ulmin
9	Unclasp	9	User	9	Upmost	9	Ulnar
10	Unclean	10	Usher	10	Upon	10	Ulterior
11	Unclose	11	Ushered	11	Upper	11	Ultimate
12	Uncouple	12	Ustion	12	Uppish	12	Ultimo
13	Uncover	13	Usual	13	Upraise	13	Ultra
14	Uncut	14	Usually	14(Pl.II,*c*)	Uprear	14	Ultraism
15	Under	15	Usufruct	15(Pl.II,*e*)	Upright	15	Ultraist
16(Pl.I,*e*)	Undergo	16(Pl.II,*a*)	Usure	16	Uprise	16	Ululate
17	Undone	17(Pl.II,*b*)	Usurer	17	Uproar		
18	Uneasy(Fg.89)	18	Usurious	18	Uproot		
19	Unfair	19	Usurp	19	Uprouse		
20	Unfit	20	Usurped	20	Upset		
21	Unflawed	21	Usurper	21	Upshot		
22	Unfold	22	Usurping	22	Upspring		
23	Unhurt	23	Usury	23	Upstand		
24	Union	24	Utensil	24	Upstart	Approx. Tents	
25	Unite	25	Utile	25	Upstay	*Ridges*	*Code*
26	Unkind	26	Utility	26	Upswarm		
27	Unlace	27	Utilize	27	Uptake	1	Umbel
28	Unlaid	28	Utilized	28	Uptear	2	Umbellar
29	Unload	29	Utis	29	Upturn	3	Umbellate
30	Unlock	30	Utmost	30	Upwind	4	Umber
31	Unman	31	Utopia	31	Uranus	5	Umbered
32	Unmove	32	Utopian	32	Urbane	6	Umbilical
33	Unpack	33	Utricle	33	Urchin	7	Umbles
34	Unpaid	34	Utter	34	Urge	8	Umbo
35	Unravel	35	Utterable	35	Urgent	9	Umbonate
36	Unreal	36	Utterance	36	Urim	10	Umbonated
37	Unrip	37	Uttered	37	Urn	11	Umbra
38	Unroot	38	Uttermost	38	Urry	12	Umbrage
39	Unruly	39	Uveous	39	Ursa	13	Umbrella
40	Unsafe	40	Uvula	40	Ursine	14	Umbrose
41	Unsaid	41	Uxorious	41	Ursuline	15	Umpirage
42	Unship	42	Uxoriously	42	Urus	16	Umpire

If the ridges of Ulnar Loops cannot be counted for any reason, use the word ULNAR; the remaining nine code words will find the duplicate.

WHORLS

Inside		Meeting		Outside	
Ridges	*Code*	*Ridges*	*Code*	*Ridges*	*Code*
3(Pl. III,*a*)	Wabble	None (Pl. III,*c*)	Weak	3	Whale
4	Wad			4	Whame
5	Wade	1 in. (Pl. III, *d*)	Web	5	Wharf Pl. III,*f*
6	Wader	2 in.	Wedge	6	What and IV,*f*
7	Water			7	Wheat
8	Waffle	1 outside	Weed	8 Pl. III, *e*	Wheel
9	Waft	2 outside	West	9 and IV,*e*	Wheeze
10	Wag			10	Whelm
11	Wage			11	Whelp
12	Wager			12	When
13	Wagon			13	Where
14	Waif			14	Wherry
15	Wail			15	Whet
16	Wain			16	Whey
17	Wair			17	Which
18	Waist			18	Whiff
19	Wait			19	Whig
20	Waiter			20	While
21	Wake			21	Whim
22	Waken			22	Whip
23	Wale			23	Whisk
24	Walk			24	Whistle
25	Wall			25	Whiting
26	Wallet			26	Whole
27	Wallow			27	Wick
28	Walnut			28	Wide
29	Walrus			29	Widow
30	Waltz			30	Width
31	Wan			31	Wield
32	Wand			32	Wife
33	Wane			33	Wild
34	Want			34	Will
35	Wanton			35	Willow
36	Wapiti			36	Wilt
37	Ward			37	Wind
38	Warder			38	Wink
39	Warm			39	Wipe
	WARP				WISE

If the ridges of the whorls included in the above table cannot be counted, use the word WARP for Inside Whorls; and the word WISE if the tracing is outside. If neither tracing nor counting can be determined, use the word WHORL; the remaining nine code words will find the duplicate.

ELONGATED WHORLS

Inside

Ridges	*Code*
3	Woad
4	Woden
5	Woe
6	Woeful
7	Wolf
8	Wolfish
9	Woman
10	Wombat
11	Won
12	Wone
13	Wonder
14	Wondrous
15	Wont
16	Word
17	Wordy
18	Wore
19	Work
20	Workbag
21	World
22	Worldly
23	Worm
24	Wormed
25	Worn
26	Wornout
27	Wornil
28	Worral
29	Worry
30	Worse
31	Worship
32	Worst
33	Wort
34	Worth
35	Worthy

Inside

Ridges	*Code*
36	Wot
37	Would
38	Wound
39	Wounded
	WOVE

Meeting

Ridges	*Code*
None	Wraith
1 inside	Wrangle
2 inside	Wrangler
1 outside	Wranglesome
2 outside	Wrangling

Outside

Ridges	*Code*
3	Wrap (Pl. IV, *d*)
4	Wrapper
5	Wrasse
6	Wrath
7	Wrathful

Outside

Ridges	*Code*
8	Wrathy
9	Wrawe
10	Wreak
11	Wreath
12	Wreathing
13	Wreck
14	Wrecker
15	Wreckful
16	Wren
17	Wrench
18	Wrest
19	Wrestle
20	Wretch
21	Wretched
22	Wretchedly
23	Wrig
24	Wriggle
25	Wriggler
26	Wring
27	Wringer
28	Wrinkle
29	Wrinkled
30	Writ
31	Writer
32	Writhe
33	Writing
34	Written
35	Wrizzled
36	Wrong
37	Wrote
38	Wroth
39	Wrought
	WRYNECK

Whorls having vertical diameters in their centers, between two and three times greater than their horizontal diameters, may be considered Elongated Whorls and the above special table is allotted for such. Measuring will not be necessary to establish the relative difference between the horizontal and vertical diameters; the judgment of the unaided eye will answer all requirements. Where the ridges of the Elongated Whorls cannot be counted, use the word WOVE if the tracing is inside; and the word WRYNECK if the tracing is outside. If neither tracing nor counting can be determined, use the word WHORL; the remaining nine code words will find the duplicate.

Age				Weight			
				Pounds		320	Owe
15	Yacht	49	Yearly	75	Oaf	325	Owner
16	Yachting	50	Yearn	80	Oak	330	Ox
17	Yager	51	Yeast	85	Oar	335	Oxyd
18	Yahoo	52	Yeasty	90	Oat	340	Oxygen
19	Yak	53	Yelk	95	Obdure	345	Oyster
20	Yam	54	Yelp	100	Obey	350	Ozone
21	Yanolite	55	Yenite	105	Object		
22	Yap	56	Yeoman	110	Oblate		
23	Yapon	57	Yeomanry	115	Oblige		
24	Yard	58	Yerk	120	Obscure		
25	Yardarm	59	Yester	125	Observe		
26	Yardland	60	Yet	130	Obtain		
27	Yardstick	61	Yfere	135	Obtest		
28	Yare	62	Yeven	140	Obtrude		
29	Yarely	63	Yew	145	Obtuse		
30	Yarn	64	Yex	150	Occult		
31	Yarnut	65	Yield	155	Occur		
32	Yarr	66	Yojan	160	Ocean		
33	Yarrish	67	Yoke	165	Octave		
34	Yarrow	68	Yold	170	Odd		
35	Yataghan	69	Yonder	175	Odor		
36	Yate	70	Yonker	180	Offer		
37	Yaup	71	Younker	185	Ogle		
38	Yaw	72	Your	190	Oily		
39	Yawl	73	Ypight	195	Oleon		
40	Yawn	74	Yttria	200	Olive		
41	Yawned	75	Yuck	205	Omen		
42	Yaws	76	Yufts	210	Once		
43	Ycled	77	Yug	215	Onion		
44	Yclept	78	Yulan	220	Onset		
45	Ydrad	79	Yule	225	Onyx		
46	Yea	80	Yux	230	Opal		
47	Year			235	Open		
48	Yearning			240	Oppose		
				245	Optic		
				250	Orator		
				255	Orbit		
				260	Order		
				265	Organ		
				270	Orlop		
				275	Ounce		
				280	Oust		
				285	Outbid		
				290	Outset		
				300	Oval		
				305	Over		
				310	Overt		
				315	Ovum		

EYES, English Description		EYES, By the Bertillon Chart in colors		
		Class I, Unpigmented		
	Code	*Code*	*Code*	*Code*
Light Blue,	Idea	Ile	Ileum	Ilex
Azure Blue,	Ideal	Iliac	Iliad	Ilk
Violet Blue,	Idealize	Ill	Illapse	Illbred
Slate Blue,	Ideate			
Dark Blue,	Idem			
Brown and Blue,	Ides	**Class II, Pigmented Yellow**		
Light Slate,	Idest	Image	Imbead	Immesh
Greenish Slate,	Idiom	Immet	Immure	Imp
Medium Slate,	Idiot	Impact	Impair	Impale
Brown and Slate,	Idleness			
Yellowish Slate,	Idler			
		Class III, Pigmented Orange		
Light Brown,	Idly	Inarch	Inbreed	Inca
Medium Brown,	Idol	Incase	Incask	Incense
Dark Brown,	Idolatry	Incide	Incise	Incite
Medium Maroon,	Idolism			
Greenish Maroon,	Idolize			
Dark Maroon,	Idolous	**Class IV, Pigmented Brown**		
Black,	Idyllic	Indent	Index	India
		Indigo	Indirect	Inditch
		Induce	Induct	Indulge
		Class V, Pigmented Maroon		
		Infame	Infant	Infect
		Infer	Infest	Infidel
		Infinite	Infirm	Inflame
		Classes VI and VII, Pigmented Greenish Maroon		
		Inscribe	Insect	Inserve
		Insight	Insipid	Insist
		Insnare	Inspect	Inspire

Nose

Ridge	*Base*	*Code*
(Concave),	(Elevated),	Nab
	Elevated,	Nabob
	Elevated,	Nacre
	Horizontal,	Nail
	Depressed,	Naked
	Depressed,	Nape
Concave,	(Elevated),	Naphtha
	Elevated,	Napkin
	Elevated,	Nappal
	Horizontal,	Nard
	Depressed,	Narwhal
	Depressed,	Nasal
Concave,	(Elevated),	Natal
	Elevated,	Nation
	Elevated,	Native
	Horizontal,	Natron
	Depressed,	Natty
	Depressed,	Nature
Rectilinear,	(Elevated),	Neap
	Elevated,	Near
	Elevated,	Needle
	Horizontal,	Neigh
	Depressed,	Nerve
	Depressed,	Nest
(Convex),	(Elevated),	Niantic
	Elevated,	Nib
	Elevated,	Nibble
	Horizontal,	Nice
	Depressed,	Nick
	Depressed,	Nickel
Convex,	(Elevated),	Niece
	Elevated,	Night
	Elevated,	Nimbus
	Horizontal,	Nip
	Depressed,	Nipple
	Depressed,	Nisan
Convex,	(Elevated),	Niter
	Elevated,	Nitid
	Elevated,	Nitrate
	Horizontal,	Nitric
	Depressed,	Nitrous
	Depressed,	Nittal
	Humped,	Nival
	Been broken,	Nizam

Dimensions	*Code*
Short and Narrow,	Nome
Short and Medium,	Nominal
Short and Broad,	Nominee
Medium and Narrow,	Nonage
Medium and Medium,	None
Medium and Broad,	Noon
Long and Narrow,	Nope
Long and Medium,	Normal
Long and Broad,	Notch

Color of Hair

	Code
Flaxen,	Jackal
Light Blonde,	Jacket
Medium Blonde,	Jaconet
Dark Blonde,	Jade
Blonde and Gray mixed,	Jaggy
Blonde and Bald,	Jalap
Blonde, Gray and Bald,	Jamb
Light Sandy,	Jane
Medium Sandy,	Jape
Dark Sandy,	Jar
Sandy and Gray mixed,	Jargon
Sandy and Bald,	Jasper
Sandy, Gray and Bald,	Jaunce
Light Red,	Jaunt
Mahogany Red,	Javel
Chestnut Red,	Jay
Red and Gray mixed,	Jean
Red and Bald,	Jeer
Red, Gray and Bald,	Jelly
Light Chestnut,	Jerk
Medium Chestnut,	Jersey
Dark Chestnut,	Jest
Chestnut and Gray mixed,	Jet
Chestnut and Bald,	Jib
Chestnut, Gray and Bald,	Jill
Chestnut Black,	Job
Chestnut, Black and Gray,	Jocose
Chestnut, Black and Bald,	Joint
Chestnut, Black, Gray and Bald,	Joist
BLACK,	Joke
Black and Gray mixed,	Jole
Black and Bald,	Jolly
Black, Gray and Bald,	Jolt
Entirely Bald,	Jot

Head Length		Head Breadth		Left Middle Finger	
16.5	Habit	13.1	Heal	9.0	Dab
16.6	Habitual	13.2	Heam	9.1	Dabble
16.7	Hack	13.3	Heap	9.2	Dace
16.8	Hackle	13.4	Heaper	9.3	Daddy
16.9	Hackney	13.5	Hear	9.4	Dado
17.0	Haddock	13.6	Heard	9.5	Daft
17.1	Hades	13.7	Hearse	9.6	Dag
17.2	Haft	13.8	Heart	9.7	Dagger
17.3	Hag	13.9	Hearten	9.8	Daily
17.4	Haggard	14.0	Hearth	9.9	Dainty
17.5	Hail	14.1	Hearty	10.0	Dairy
17.6	Hake	14.2	Heat	10.1	Daisy
17.7	Hakot	14.3	Heated	10.2	Dally
17.8	Halberd	14.4	Heath	10.3	Dam
17.9	Half	14.5	Heathen	10.4	Damask
18.0	Halibut	14.6	Heather	10.5	Dame
18.1	Hall	14.7	Heave	10.6	Damp
18.2	Halyard	14.8	Heaven	10.7	Damsel
18.3	Hallow	14.9	Heaves	10.8	Dan
18.4	Halt	15.0	Heavy	10.9	Dance
18.5	Halter	15.1	Heazy	11.0	Dander
18.6	Ham	15.2	Hebe	11.1	Dandy
18.7	Hames	15.3	Hebete	11.2	Dane
18.8	Hamlet	15.4	Hecatomb	11.3	Danger
18.9	Hammer	15.5	Heckle	11.4	Dank
19.0	Hammock	15.6	Hector	11.5	Dapple
19.1	Hamper	15.7	Hedge	11.6	Dard
19.2	Handle	15.8	Heed	11.7	Dare
19.3	Handsaw	15.9	Heel	11.8	Darken
19.4	Handy	16.0	Heifer	11.9	Darling
19.5	Hant	16.1	Heir	12.0	Darn
19.6	Happen	16.2	Heem	12.1	Dart
19.7	Harbor	16.3	Henbane	12.2	Dash
19.8	Hard	16.4	Hepar	12.3	Dastard
19.9	Hardy	16.5	Herald	12.4	Date
20.0	Harem	16.6	Herb	12.5	Dative
20.1	Harm	16.7	Herby	12.6	Datum
20.2	Harmony	16.8	Heresy	12.7	Daub
20.3	Harness	16.9	Hermit	12.8	Daunt
20.4	Harp	17.0	Hero	12.9	Dauphin
20.5	Harpy	17.1	Heron	13.0	Davit
20.6	Harrow	17.2	Herring	13.1	Daw
20.7	Harsh	17.3	Herse	13.2	Dawdle
20.8	Harvest			13.3	Dawk
20.9	Hasp			13.4	Dawn
21.0	Hat			13.5	Day
21.1	Hatch			13.6	Daybreak
21.2	Hatchet			13.7	Daydream
21.3	Hate			13.8	Dayfly
21.4	Haunt			13.9	Daze
				14.0	Dazzle

LENGTH OF LEFT FOOT

22.0	Fable	25.2	Fan	28.7	Felt
22.1	Fabric	25.3	Fanatic	28.8	Fence
22.2	Fabulous	25.4	Fancy	28.9	Fend
22.3	Facade	25.5	Fang	29.0	Ferment
22.4	Facet	25.6	Fantasy	29.1	Fern
22.5	Facile	25.7	Farce	29.2	Ferret
22.6	Facility	25.8	Fardel	29.3	Ferry
22.7	Fact	25.9	Fare	29.4	Fertile
22.8	Faction	26.0	Farina	29.5	Fervent
22.9	Factor	26.1	Farm	29.6	Festive
23.0	Faculty	26.2	Farrier	29.7	Fetch
23.1	Fade	26.3	Farrow	29.8	Fetid
23.2	Fag	26.4	Fashion	29.9	Feud
23.3	Fagot	26.5	Fast	30.0	Fever
23.4	Fail	26.6	Fat	30.1	Fiat
23.5	Failure	26.7	Fatal	30.2	Fibrin
23.6	Fain	26.8	Fate	30.3	Fiddle
23.7	Faint	26.9	Fathom	30.4	Fidget
23.8	Fair	27.0	Fatigue	30.5	Field
23.9	Fairy	27.1	Fault	30.6	Fig
24.0	Faith	27.2	Faun	30.7	Fight
24.1	Fake	27.3	Fauna	30.8	File
24.2	Falcon	27.4	Faust	30.9	Fill
24.3	Fall	27.5	Favor	31.0	Film
24.4	Fallax	27.6	Favose	31.1	Filter
24.5	Fallow	27.7	Faxed	31.2	Filth
24.6	False	27.8	Fay	31.3	Fin
24.7	Falter	27.9	Fear	31.4	Final
24.8	Fame	28.0	Feast	31.5	Fire
24.9	Family	28.1	Feather	31.6	Firkin
25.0	Famish	28.2	Feeble	31.7	Firm
25.1	Famous	28.3	Feed	31.8	Fish
		28.4	Feign	31.9	Fit
		28.5	Feline	32.0	Fix
		28.6	Fell		

LENGTH OF LEFT FOREARM

39.6	Gab	44.6	Gay	49.7	Gland
39.7	Gabble	44.7	Gaze	49.8	Glare
39.8	Gabel	44.8	Gazon	49.9	Glass
39.9	Gabion	44.9	Gear	50.0	Glave
40.0	Gable	45.0	Gelt	50.1	Glaze
40.1	Gaby	45.1	Gelid	50.2	Gleam
40.2	Gad	45.2	Gemel	50.3	Glebe
40.3	Gadoid	45.3	Gemote	50.4	Glee
40.4	Gaelic	45.4	Gender	50.5	Glen
40.5	Gaff	45.5	Genesis	50.6	Glib
40.6	Gag	45.6	Genet	50.7	Glide
40.7	Gage	45.7	Geneva	50.8	Glim
40.8	Gager	45.8	Genial	50.9	Glisten
40.9	Gaily	45.9	Genio	51.0	Gloam
41.0	Gain	46.0	Genius	51.1	Gloat
41.1	Gait	46.1	Gentle	51.2	Globe
41.2	Galaxy	46.2	Genuine	51.3	Gloom
41.3	Gale	46.3	Genus	51.4	Glory
41.4	Galena	46.4	Geode	51.5	Gloss
41.5	Gall	46.5	Gerah	51.6	Glove
41.6	Galley	46.6	Germ	51.7	Glow
41.7	Gallon	46.7	Gerund	51.8	Glue
41.8	Gallop	46.8	Gest	51.9	Glut
41.9	Galore	46.9	Get	52.0	Gluten
42.0	Game	47.0	Ghost	52.1	Gnaw
42.1	Gammon	47.1	Giant	52.2	Goad
42.2	Gander	47.2	Gibe	52.3	Goal
42.3	Gang	47.3	Giddy	52.4	Goat
42.4	Gangway	47.4	Gift	52.5	Goblet
42.5	Gannet	47.5	Gig	52.6	Goggle
42.6	Gape	47.6	Giggle	52.7	Gold
42.7	Gar	47.7	Gild	52.8	Gong
42.8	Garden	47.8	Gill	52.9	Good
42.9	Gargle	47.9	Gilt	53.0	Goose
43.0	Garland	48.0	Gimbal	53.1	Gopher
43.1	Garment	48.1	Gimlet	53.2	Gore
43.2	Garner	48.2	Gimp	53.3	Gorge
43.3	Garret	48.3	Gin	53.4	Gorse
43.4	Garter	48.4	Ginger	53.5	Gospel
43.5	Garth	48.5	Ginseng	53.6	Gossip
43.6	Gas	48.6	Gipsy	53.7	Gothic
43.7	Gaskins	48.7	Giraffe	53.8	Gourd
43.8	Gasp	48.8	Gird	53.9	Govern
43.9	Gat	48.9	Girth	54.0	Gown
44.0	Gather	49.0	Give	54.1	Grab
44.1	Gaud	49.1	Gizzard	54.2	Grace
44.2	Gauge	49.2	Glacis	54.3	Grade
44.3	Gaunt	49.3	Glad	54.4	Grain
44.4	Gavel	49.4	Gladen	54.5	Granite
44.5	Gawk	49.5	Gladly	54.6	Grasp
		49.6	Glance	54.7	Grate

BERTILLON HEIGHTS

1.51.4	Mab	1.56.3	Manage	1.61.2	Marry
1.51.5	Macadam	1.56.4	Mandate	1.61.3	Mars
1.51.6	Macaroni	1.56.5	Mandril	1.61.4	Marsh
1.51.7	Macaw	1.56.6	Mane	1.61.5	Mart
1.51.8	Mace	1.56.7	Manage	1.61.6	Marten
1.51.9	Machine	1.56.8	Mandarin	1.61.7	Martyr
1.52.0	Mackerel	1.56.9	Manful	1.61.8	Marvel
1.52.1	Mackle	1.57.0	Mange	1.61.9	Mascot
1.52.2	Mad	1.57.1	Manger	1.62.0	Mash
1.52.3	Madam	1.57.2	Mangle	1.62.1	Mashy
1.52.4	Madcap	1.57.3	Mango	1.62.2	Mask
1.52.5	Madder	1.57.4	Mangrove	1.62.3	Maslin
1.52.6	MADE (5′ 0″)	1.57.5	Mangy	1.62.4	Mason
1.52.7	Madeira	1.57.6	MANHOLE (5′2″)	1.62.5	Mass
1.52.8	Madonna	1.57.7	Manhood	1.62.6	Massive
1.52.9	Madrid	1.57.8	Manifest	1.62.7	Mast
1.53.0	Madrigal	1.57.9	Manifold	1.62.8	MASTER (5′ 4″)
1.53.1	Maduro	1.58.0	Manikin	1.62.9	Mastic
1.53.2	Maffia	1.58.1	Manis	1.63.0	Mastiff
1.53.3	Magazine	1.58.2	Mankind	1.63.1	Mastoid
1.53.4	Mage	1.58.3	Manly	1.63.2	Mat
1.53.5	Maggot	1.58.4	Manner	1.63.3	Match
1.53.6	Magi	1.58.5	Manor	1.63.4	Mate
1.53.7	Magic	1.58.6	Mantle	1.63.5	Mater
1.53.8	Maglip	1.58.7	Manumit	1.63.6	Material
1.53.9	Magma	1.58.8	Manure	1.63.7	Maternal
1.54.0	Magnate	1.58.9	Many	1.63.8	Mathes
1.54.1	Magnify	1.59.0	Manx	1.63.9	Matin
1.54.2	Magnolia	1.59.1	Map	1.64.0	Mattress
1.54.3	Magpie	1.59.2	Maple	1.64.1	Matrix
1.54.4	Maid	1.59.3	Mar	1.64.2	Matron
1.54.5	Mail	1.59.4	Marauder	1.64.3	Matter
1.54.6	Maim	1.59.5	Marble	1.64.4	Mattock
1.54.7	Mainly	1.59.6	March	1.64.5	Mature
1.54.8	Maintain	1.59.7	Marconi	1.64.6	Maudlin
1.54.9	Maintop	1.59.8	Mare	1.64.7	Maul
1.55.0	Maize	1.59.9	Margin	1.64.8	Mauve
1.55.1	MAJESTIC (5′ 1″)	1.60.0	Marine	1.64.9	Maxim
1.55.2	Major	1.60.1	Marital	1.65.0	Maw
1.55.3	Make	1.60.2	MARK (5′ 3″)	1.65.1	Mayday
1.55.4	Maki	1.60.3	Market	1.65.2	Mayor
1.55.5	Malady	1.60.4	Marksman	1.65.3	MAZE (5′ 5″)
1.55.6	Malic	1.60.5	Marl	1.65.4	Mead
1.55.7	Mall	1.60.6	Marline	1.65.5	Meadow
1.55.8	Mallet	1.60.7	Marmot	1.65.6	Meagre
1.55.9	Malodor	1.60.8	Maroon	1.65.7	Meal
1.56.0	Malt	1.60.9	Marquis	1.65.8	Mean
1.56.1	Mammal	1.61.0	Marriage	1.65.9	Measly
1.56.2	Mammon	1.61.1	Marrow	1.66.0	Measure

Bertillon Heights

1.66.1	Meat	1.71.0	Mica	1.75.9	Mizzen
1.66.2	Mechanic	1.71.1	Middle	1.76.0	Moan
1.66.3	Mechanism	1.71.2	Midland	1.76.1	Moat
1.66.4	Medal	1.71.3	Midnight	1.76.2	Mobile
1.66.5	Mediate	1.71.4	Midship	1.76.3	Mock
1.66.6	Medical	1.71.5	Midway	1.76.4	Mode
1.66.7	Medicine	1.71.6	Might	1.76.5	Model
1.66.8	Medium	1.71.7	Milch	1.76.6	Modern
1.66.9	Medley	1.71.8	Mild	1.76.7	Modify
1.67.0	Medusa	1.71.9	Mildew	1.76.8	Mohair
1.67.1	Meek	1.72.0	Mile	1.76.9	Moist
1.67.2	Meeting	1.72.1	Militia	1.77.0	Molar
1.67.3	Megrim	1.72.2	Milk	1.77.1	Molasses
1.67.4	Melee	1.72.3	Milkman	1.77.2	Molest
1.67.5	Melic	1.72.4	Mill	1.77.3	Moult
1.67.6	Melinite	1.72.5	Miller	1.77.4	Molten
1.67.7	Mellow	1.72.6	Million	1.77.5	Moment
1.67.8	MELODY (5′ 6″)	1.72.7	Milt	1.77.6	Monad
1.67.9	Melon	1.72.8	Mimic	1.77.7	Monarch
1.68.0	Melrose	1.72.9	MINCE (5′ 8″)	1.77.8	Money
1.68.1	Melt	1.73.0	Mind	1.77.9	Mongrel
1.68.2	Member	1.73.1	Mineral	1.78.0	MONITOR (5′ 10″)
1.68.3	Memoir	1.73.2	Minerva	1.78.1	Monk
1.68.4	Memory	1.73.3	Mingle	1.78.2	Monkey
1.68.5	Menace	1.73.4	Minim	1.78.3	Monotony
1.68.6	Mend	1.73.5	Mink	1.78.4	Monster
1.68.7	Menial	1.73.6	Minor	1.78.5	Month
1.68.8	Mental	1.73.7	Minstrel	1.78.6	Mood
1.68.9	Mention	1.73.8	Mint	1.78.7	Moon
1.69.0	Merchant	1.73.9	Minute	1.78.8	Moor
1.69.1	Mercury	1.74.0	Miracle	1.78.9	Moose
1.69.2	Mercy	1.74.1	Mire	1.79.0	Mope
1.69.3	Mere	1.74.2	Mirror	1.79.1	Moral
1.69.4	Merino	1.74.3	Mirth	1.79.2	Morass
1.69.5	Merit	1.74.4	Miscast	1.79.3	Morose
1.69.6	Merlin	1.74.5	Miser	1.79.4	Mordant
1.69.7	Merry	1.74.6	Misgive	1.79.5	Morn
1.69.8	Mersion	1.74.7	Mislay	1.79.6	Morse
1.69.9	Mess	1.74.8	Misrule	1.79.7	Mortal
1.70.0	Message	1.74.9	Miss	1.79.8	Morter
1.70.1	Metal	1.75.0	Missile	1.79.9	Mortise
1.70.2	Metaphor	1.75.1	Mission	1.80.0	Mosaic
1.70.3	Mete	1.75.2	Mist	1.80.1	Moss
1.70.4	METEOR (5′ 7″)	1.75.3	Mistake	1.80.2	Mote
1.70.5	Method	1.75.4	Mister	1.80.3	Moth
1.70.6	Mettle	1.75.5	MISUSE (5′ 9″)	1.80.4	Mother
1.70.7	Mew	1.75.6	Mitre	1.80.5	MOTION (5′ 11″)
1.70.8	Mezzo	1.75.7	Mitten	1.80.6	Motive
1.70.9	Miasma	1.75.8	Mixture	1.80.7	Mold

Bertillon Heights

1.80.8	Mound
1.80.9	Mourn
1.81.0	Mouse
1.81.1	Mouth
1.81.2	Move
1.81.3	Mown
1.81.4	Much
1.81.5	Muckle
1.81.6	Mucus
1.81.7	Mud
1.81.8	Muff
1.81.9	Mug
1.82.0	Mugwort
1.82.1	Mule
1.82.2	Mullen
1.82.3	Multiple
1.82.4	Multiplex
1.82.5	Multiply
1.82.6	Multitude
1.82.7	Mum
1.82.8	Mumble
1.82.9	Mumbo
1.83.0	MUMMER (6′)
1.83.1	Mummy
1.83.2	Mump
1.83.3	Munch
1.83.4	Mundane
1.83.5	Mundic
1.83.6	Munition
1.83.7	Munite
1.83.8	Munity
1.83.9	Munnion
1.84.0	Mural
1.84.1	Mure
1.84.2	Murex
1.84.3	Muriate
1.84.4	Murk
1.84.5	Murky
1.84.6	Murmur
1.84.7	Murrain
1.84.8	Murrey
1.84.9	Murza
1.85.0	Musard
1.85.1	Muscat
1.85.2	Muscle
1.85.3	Muscoid
1.85.4	Muscovy
1.85.5	MUSE (6′ 1″)
1.85.6	Musette
1.85.7	Museum
1.85.8	Mush
1.85.9	Mushroom
1.86.0	Music
1.86.1	Musing
1.86.2	Musk
1.86.3	Musket
1.86.4	Muskox
1.86.5	Muskrat
1.86.6	Muslin
1.86.7	Muss
1.86.8	Mussel
1.86.9	Must
1.87.0	Mustard
1.87.1	Mustee
1.87.2	Muster
1.87.3	Musty
1.87.4	Mutable
1.87.5	Mutage
1.87.6	Mutation
1.87.7	Mute
1.87.8	Mutely
1.87.9	Muteness
1.88.0	MUTINE (6′ 2″)
1.88.1	Mutiny
1.88.2	Mutter
1.88.3	Mutton
1.88.4	Mutual
1.88.5	Mutule
1.88.6	Muxy
1.88.7	Muzzle
1.88.8	Muzzling
1.88.9	Muzzy
1.89.0	Mynheer
1.89.1	Myology
1.89.2	Myopy
1.89.3	Myriad
1.89.4	Myriapod
1.89.5	Myriare
1.89.6	Myricin
1.89.7	Myrmidon
1.89.8	Myrobalan
1.89.9	Myron
1.90.0	Myrrh
1.90.1	Myrrhine
1.90.2	Myrtle
1.90.3	Myrus
1.90.4	Mystax
1.90.5	MYSTERIAL (6′ 3″)

BERTILLON HEIGHTS

1.90.6	Mystery	1.91.1	Mystify
1.90.7	Mystic	1.91.2	Myth
1.90.8	Mystical	1.91.3	Mythical
1.90.9	Mysticism	1.91.4	Mythology
1.91.0	Mystics	1.91.5	Myxon

LITTLE FINGER LENGTH

6.8	Deacon	9.3	Defy
6.9	Deaf	9.4	Delay
7.0	Deal	9.5	Delft
7.1	Debar	9.6	Deluge
7.2	Debase	9.7	Delve
7.3	Debate	9.8	Demon
7.4	Debit	9.9	Demur
7.5	Decade	10.0	Denial
7.6	Decay	10.1	Denizen
7.7	Deceit	10.2	Dense
7.8	Decent	10.3	Dental
7.9	Decide	10.4	Deny
8.0	Deck	10.5	Depart
8.1	Declare	10.6	Depend
8.2	Decline	10.7	Deplore
8.3	Decoy	10.8	Deploy
8.4	Decry	10.9	Deport
8.5	Deduct	11.0	Depot
8.6	Deep	11.1	Depress
8.7	Deer	11.2	Depth
8.8	Deface	11.3	Deride
8.9	Defeat	11.4	Descend
9.0	Defile	11.5	Desert
9.1	Defix	11.6	Design
9.2	Deform	11.7	Desire

Height of Body

76.1	Baal	81.0	Basic	85.9	Belfry	90.8	Bird
76.2	Babe	81.1	Basil	86.0	Belie	90.9	Birth
76.3	Babel	81.2	Basin	86.1	Belief	91.0	Bishop
76.4	Back	81.3	Bask	86.2	Bell	91.1	Bisk
76.5	Bacon	81.4	Basket	86.3	Bellon	91.2	Bison
76.6	Badger	81.5	Baste	86.4	Bellow	91.3	Bister
76.7	Baffle	81.6	Bat	86.5	Belly	91.4	Bit
76.8	Bait	81.7	Batch	86.6	Belt	91.5	Bite
76.9	Baize	81.8	Bath	86.7	Bema	91.6	Bitter
77.0	Bake	81.9	Baton	86.8	Bemoan	91.7	Bitts
77.1	Balan	82.0	Bawl	86.9	Bench	91.8	Bivouac
77.2	Balance	82.1	Bay	87.0	Bend	91.9	Blab
77.3	Balcony	82.2	Bazar	87.1	Benedict	92.0	Blade
77.4	Bale	82.3	Beach	87.2	Benefit	92.1	Blame
77.5	Balk	82.4	Beacon	87.3	Benign	92.2	Blanch
77.6	Ball	82.5	Bead	87.4	Bent	92.3	Bland
77.7	Ballard	82.6	Beadle	87.5	Berg	92.4	Blank
77.8	Ballast	82.7	Beak	87.6	Berlin	92.5	Blare
77.9	Ballet	82.8	Beam	87.7	Berry	92.6	Blast
78.0	Balm	82.9	Bear	87.8	Beryl	92.7	Blay
78.1	Balmy	83.0	Beard	87.9	Beseech	92.8	Blaze
78.2	Balsam	83.1	Beast	88.0	Beside	92.9	Bleach
78.3	Baltic	83.2	Beat	88.1	Best	93.0	Bleak
78.4	Bamboo	83.3	Beau	88.2	Bestir	93.1	Blear
78.5	Banana	83.4	Beck	88.3	Betake	93.2	Bleed
78.6	Band	83.5	Become	88.4	Betel	93.3	Blemish
78.7	Bandage	83.6	Bed	88.5	Betide	93.4	Blend
78.8	Bandle	83.7	Bedlam	88.6	Betray	93.5	Bless
78.9	Bandy	83.8	Bedpost	88.7	Better	93.6	Blest
79.0	Bane	83.9	Bedquilt	88.8	Bevel	93.7	Blight
79.1	Bang	84.0	Bee	88.9	Bevy	93.8	Blind
79.2	Bangle	84.1	Beech	89.0	Beware	93.9	Blink
79.3	Banner	84.2	Beef	89.1	Beyond	94.0	Bliss
79.4	Baptism	84.3	Beehive	89.2	Bias	94.1	Blister
79.5	Barb	84.4	Beer	89.3	Bib	94.2	Block
79.6	Barbel	84.5	Beet	89.4	Bible	94.3	Blood
79.7	Bard	84.6	Beetle	89.5	Bicker	94.4	Bloom
79.8	Bare	84.7	Befit	89.6	Bid	94.5	Blot
79.9	Barge	84.8	Before	89.7	Bidding	94.6	Blow
80.0	Bark	84.9	Befoul	89.8	Biform	94.7	Blowse
80.1	Barn	85.0	Beg	89.9	Bight	94.8	Blub
80.2	Baron	85.1	Beget	90.0	Bigot	94.9	Bluff
80.3	Barrel	85.2	Begin	90.1	Bilbo	95.0	Blunt
80.4	Barren	85.3	Behave	90.2	Bile	95.1	Blur
80.5	Barrow	85.4	Behest	90.3	Bill	95.2	Blurt
80.6	Barter	85.5	Behind	90.4	Billow	95.3	Blush
80.7	Basalt	85.6	Being	90.5	Bin	95.4	Boar
80.8	Base	85.7	Belch	90.6	Bind	65.5	Board
80.9	Bashful	85.8	Beldam	90.7	Birch	95.6	Boast

HEIGHT OF BODY

95.7	Boat	97.1	Boom	98.5	Bovine	99.8	Breast
95.8	Bob	97.2	Boor	98.6	Bow	99.9	Breath
95.9	Bode	97.3	Boost	98.7	Bowel	1.00.0	Breed
96.0	Bodice	97.4	Boot	98.8	Bowl	1.00.1	Breeze
96.1	Bog	97.5	Booth	98.9	Box	1.00.2	Brew
96.2	Boggle	97.6	Borax	99.0	Brace	1.00.3	Brick
96.3	Boil	97.7	Bore	99.1	Brag	1.00.4	Bride
96.4	Bold	97.8	Boss	99.2	Braid	1.00.5	Bridge
96.5	Bolt	97.9	Botany	99.3	Brail	1.00.6	Brief
96.6	Bond	98.0	Botch	99.4	Brain	1.00.7	Brig
96.7	Bone	98.1	Both	99.5	Brake	1.00.8	Brim
96.8	Bonny	98.2	Bottle	99.6	Bread	1.00.9	Brink
96.9	Bonze	98.3	Bottom	99.7	Bream	1.01.0	Brisk
97.0	Book	98.4	Bourn				

OUTSTRETCHED ARMS

1.50.0	Sabine	1.80.0	Slit
1.51.0	Sadly	1.81.0	Sluice
1.52.0	Saliva	1.82.0	Smell
1.53.0	Sandal	1.83.0	Snag
1.54.0	Satyr	1.84.0	Snick
1.55.0	Scale	1.85.0	Snug
1.56.0	Scheme	1.86.0	Sofa
1.57.0	Score	1.87.0	Sonata
1.58.0	Scrape	1.88.0	Sort
1.59.0	Scud	1.89.0	Sot
1.60.0	Sea	1.90.0	Spasm
1.61.0	Second	1.91.0	Spend
1.62.0	Seek	1.92.0	Spire
1.63.0	Senate	1.93.0	Spong
1.64.0	Seps	1.94.0	Sprig
1.65.0	Serpent	1.95.0	Spurt
1.66.0	Sever	1.96.0	Stable
1.67.0	Shag	1.97.0	Stalk
1.68.0	Shave	1.98.0	Start
1.69.0	Shekle	1.99.0	Steep
1.70.0	Shirt	2.00.0	Sting
1.71.0	Shout		
1.72.0	Shrink		
1.73.0	Siege		
1.74.0	Silk		
1.75.0	Sing		
1.76.0	Site		
1.77.0	Skunk		
1.78.0	Slat		
1.79.0	Slice		

EAR MEASUREMENTS

Length		*Length*	
5.0	Eagle	7.8	Elf
5.1	Early	7.9	Elide
5.2	Earn	8.0	Elk
5.3	Earth	8.1	Elm
5.4	Ease	8.2	Else
5.5	East	8.3	Embalm
5.6	Easy	8.4	Embar
5.7	Eat	8.5	Embark
5.8	Eaves		
5.9	Ebb		
6.0	Ebony		
6.1	Echo		
6.2	Eddy		
6.3	Edge		
6.4	Edict		
6.5	Edit		
6.6	Educe		
6.7	Eel		
6.8	Egg		
6.9	Egret		
7.0	Eider		
7.1	Either		
7.2	Eject		
7.3	Eke		
7.4	Eland		
7.5	Elastic		
7.6	Elect		
7.7	Elegy		

EAR LOBE DESCRIPTIVE

	Code
Separated,	Excuse
Adhering,	Exert
Descending,	Exile

CHAPTER VII

ACCIDENTAL IMPRESSIONS; METHODS OF DEVELOPMENT; THEIR USE IN PROVING THE AGENCY OF A GIVEN INDIVIDUAL

Judicial Proof

"*Proof of the identity of finger prints, is that degree of certainty which precludes the possibility of accidental coincidence. Two finger prints made by any process cannot be exactly identical, if examined with microscopic accuracy. The problem is to determine whether two impressions were actually made by the same finger.*" — *Albert S. Osborn, in Questioned Documents, 1910.*

Police Practice

"*These details, which give papillary ridges a character definitely identifiable, have resulted in making finger prints an element of Judicial proof. And in fact in a great number of countries the research of this sort of traces has entered into the practice and has given the most excellent results. All smooth objects which the hand touches keep the impression, visible if it is bloody or dirty, invisible if there is only a small deposit of secretion. Windows broken by a robber, bottles and glasses from which the criminal has drunk, money drawers which the robber has opened, the furniture and the walls where he has rested his hand, will reveal to the officer the identity of the thief; the writer of anonymous letters has occasionally signed them in spite of himself by the very touch of his fingers. In all cases of misdemeanors or crimes, the finger prints are the surest means of identifying the malefactor.*" — *M. Edmond Locard, Director of the Laboratory of Police, Lyons, France. 1914.*

IN the City of Lyons, France, as soon as it is discovered that a crime has been committed, the patrolman, or whoever makes the discovery, immediately telephones to the Police Laboratory. The informant gets a formal order not to disturb anything and an officer is placed in charge to guard the place, and see that the finger marks are not obliterated. The agents attached to the Bureau can thus arrive in time to discover the traces, stains or prints, which are taken to the Laboratory; or, if that is impossible, they are photographed on the spot. In practice it is an exceptional case where no trace is left. It can be seen that the expert ought to be the first to enter the place before anything has been handled, otherwise there will be found only the prints of the idle and the curious, and possibly those of the police themselves. The authors believe if there

ever was needed the warning, "Hands Off," it is at the place where a crime has been committed. An expert photographer once told one of the authors of a prosecuting attorney rubbing with his hands the handle of a razor with which a crime had been committed, and then asking the photographer if he "could photograph the marks on it." To this the photographer promptly replied, "No, I cannot," and gave as a reason to the surprised official that the article had been handled. It is easily understood that a prosecuting attorney is capable of as much mischief under these circumstances as any other person.

In the whole subject of identification by finger prints, the public is most interested in that branch of it where the author of a crime is discovered by an imprint left at the scene, unknown to himself; or where, in addition to other proofs, further evidence is furnished by some imprint, more or less clear, found where the crime has been committed. This chapter treats of cases of this kind, with illustrations kindly furnished from different parts of the United States, France, and particularly Scotland Yard, London, to which an entire section has been alloted.

The authors have been asked many times to explain how it is that imprints left accidentally at the scene of a crime can be developed to the extent of being useful, and in general some such explanation as follows is given. The friction ridges are thickly studded with microscopic pores and through these there is a continuous flow of perspiratory secretion generally imperceptible to the naked eye. When a finger comes in contact with a smooth surface that is cold and dry, the imprints made by the ridges are left, more or less distinct, on the article touched. Where it is possible these imprints are photographed, generally larger than the original. Sometimes it is necessary before taking the photograph to bring out the imprints with some reagent, using black powder if the imprints are on a light surface, or on white paper, and white powder if the imprints are on glass or a dark surface. It will at once be seen that the visibility of these accidental imprints is thus largely increased on account of the adhesion of the powder to the moisture or oily secretion left by the ridges, and the earlier the attempt to bring out these marks the better chance of success, for there is great liability of failure if the impression has become perfectly dry.

The black powders in common use here are generally animal black, graphite, lampblack, powdered willow charcoal, black antimony, and others of a similar nature. These are used ordinarily to develop marks on paper or light surfaces; on glass or dark surfaces, "gray-powder," composed of chalk and white oxide of mercury, is used, although there are prepared powders for sale, both black and white, that are excellent for the purpose. A word of warning may not be amiss; in rolling black powder back and forth on paper to bring out the imprints, care must be

taken that the powder does not gather itself into little balls, as snow balls increase by rolling. It has been noticed in numerous experiments made by one of the authors with impressions of his own fingers, that the smallest ball of powder would obliterate the delicate lines that had just been developed and the imprints thereby be ruined. In the application of the white or gray powder a fine brush of camel's hair is used and the powder applied very lightly, in other words "patted or dusted on," and then as lightly brushed or blown off. Care must be used not to attempt to remove too much of the powder, because some of the delicate details that have just appeared may be lost with it. M. Stockis of Liége, Belgium, has originated a process of photography by indirect illumination without coloring, and M. Edmond Locard of the Laboratory of Police in Lyons, France, has been wonderfully successful by coloring with very fine reagents, and up to the present has obtained the best results with the oxides of lead, particularly the red oxide (Pb_3O_4). Still other trials with litharge and dioxide gave extremely clear results.

The practical application is as follows: if a suspicious imprint is developed with black powder, it can at once be compared with an inked imprint from a suspect, and if there seems to be doubt one way or the other, both are enlarged 5 to 6 diameters and the points of identity in each are checked up.

The commonest method of comparison is to mark the points of identity, one after another, as found, by means of lines drawn from them to the margin, and bearing letters or numbers by which to distinguish them (Figures 61 and 62 below).

Another method, devised by Albert S. Osborn, is to divide each of the two enlarged photographs into squares, both exactly alike, with the squares occupying identical positions on each, and then examine them in order, square for square, noting the points of identity in each (Chapter IX, Figure 131).

Seymour uses still another method, that of making skeleton tracings. These he makes on tracing paper; (1) from the suspected print, and (2) from a print of the accused, and compares them by placing them together and holding them up to the light.

These methods are necessary only when the two prints in question seem to be very similar. When certain and definite differences are seen by the eye, these more careful methods are not required.

Where the traces are developed by white powder, a different method is followed, as it is desired ordinarily to compare the lines comprising the developed trace with the black lines made with ink from some digit of a suspected person. In the taking of the photograph the plate is put in the plate holder *with the film side away* from the object photographed, and after the plate so made is completed, another plate is made from this,

as lantern slides are made, and the photographs printed from the last plate. This will take considerable time; to save which, for quick comparison, an imprint can be made from the digit of a suspected person by the use of white ink on glossy black paper. This has the advantage of being ready for comparison in a minute or two. Still another method suggests itself that has been tried with good success, that of taking the imprint of the suspect on a cleared photographic film, with ink, then using the film as a photographic negative with the sensitized paper underneath and not in contact with the inked side. This will give results of surprising brilliancy, Figure 85 showing the ridges as white lines with the details brought out in a wonderful manner. These can be quickly printed

FIGURE 85. This figure shows the method of taking white prints on a black background. The prints are taken directly upon a cleared film, instead of on paper, and this is used as a negative, and is printed through in the usual way. The result is shown here. The ridges appear as white lines upon a black ground, and are exceptionally clear. In many places even the pores are seen, showing as black dots on the white ridges.

and compared with the imprint that has been developed with white powder. The advantage of reversing the colors in the photograph comes from the fact that nearly everybody has examined ridges as black lines on a white surface, and but very few have examined them as white lines on black. In the Section allotted for the methods used at Scotland Yard, this subject has been gone into at some length, and all the illustrations show black lines, both those developed with white powder and those developed with black. In the development or coloring of the accidental imprint the greatest care must be used not to overdo it, because the imprint at best will be poor. It will be granted that one will never find an accidental imprint that is absolutely perfect; it is seldom, indeed, that a very good one is found, and in all the attempts to develop them, the object is to improve and not to destroy the imprint left accidentally by the criminal,—a print that will be poor at best.

It is admitted that identification does not consist merely in finding

forks, or interruptions of the ridges in homologous positions; the angular value of the forks is still necessary to consider, also the length of these interruptions and even the width of the corresponding lines. It follows then that in a light trace, or where the center of the figure is effaced, it is necessary to be particularly observant about the appearance of each of the points under observation.

Locard summarizes the principles of Identification from Impressions, as he sees them, as follows: *

Three cases may be presented:

1. There are more than 12 evident points; the impression is clear; *absolute identification.*

2. There are 8—12 points; limited cases; certainty depends upon:
   (*a*) the clearness of the impression;
   (*b*) the rarity of the type;
   (*c*) the presence of the center of the figure [core] or the triangle [delta] in the part that is decipherable;
   (*d*) the presence of pores;
   (*e*) the perfect and evident identity of the breadth of the ridges and furrows, of the direction of the lines, and the angular value of the forks.

   In these cases certainty of identification is to be established *only after the discussion of the case by one or more competent and experienced specialists.*

3. There are very few points; in this case the print, taken by itself, does not furnish certain identity, but only a presumption proportional to the number and clearness of the points.

If there is a series of impressions in the same case, and none suffices of itself to establish absolute certainty, what of their total value? We must here distinguish three cases:

(*a*) The same finger is repeated many times: if certain points of identity are discernible on one impression and not on another, it is proper to add them. Let us suppose, for example, that the impression of the Right Index is found on a bottle three times; that the best impression shows 10 points, the second five of these already seen on the first, together with two new ones; that the third shows four points already identified on either the first or the second, together with three new ones; we would

*From La Preuve Judiciaire par les Empreintes Digitales, by Edmond Locard, Director of the Police Laboratory at Lyons, France. Published at Lyons by A. Rey, 1914, pp. 16–17.

then say that the identification of the impressions with the Right Index of the accused is made by $10 + 2 + 3 = 15$ points. With any one of the three prints the identification was only presumptive; with the entire series it becomes positive.

(*b*) There are many different impressions, each of which offers some presumption of identity with the finger patterns of the accused, but no one of which is determined by its position as coming from a certain finger. Such would be the case if we found, for example, one impression on the neck of a bottle, and another along the middle; one could not say whether, from their position, they came from an Index and Middle finger, or from a Ring and a Little finger. If the first presents six points in common with the Right Index of the accused, and the second four points in common with his Left Ring finger, the presumption of identity is strengthened, but we cannot call this positive identification, since we find ourselves facing a double coincidence.

(*c*) There are many impressions of successive fingers, as shown by their position. This is the very common case where an object, seized by the open hand, presents, side by side, and in their natural order, the impressions of the Index, Middle, Ring, and Little fingers, with, on the other side of the object, the impression of the opposing thumb. If all of the impressions are individually insufficient; if, for example, they offer 7, 9, 8, and 11 points of identity respectively, corresponding to homologous points upon the accused, one should not hesitate to conclude positive identification, since the force of increasing certainty here follows the Law of Exponents [the one explained in Chapter X, regarding the identification of the body of Marie Rôget]. In fact, it is not sufficient to say that, in such a case, the points are to be added; the coincidence in form in the whole series of finger patterns represents a number of possibilities of error infinitely smaller than where the fingers themselves are not determined [Case *b* above].

The reader will naturally ask, what constitutes an identification after all the different combinations have been considered, and the answer must

be, that it depends upon the number and position of the points of identity, although the calculations (generally accepted) based on the researches of Galton, Féré, Balthazard, Oloriz and others appear to show that *certain* identity can scarcely be claimed without at least 12 homologous points of comparison. The above is the generally accepted rule, with the exceptions noted, yet the authors and some others feel that six or eight points well grouped, defining a center of exceptional form, constitutes such a perfect proof of identity as to give no grounds for argument, while double the number of forks disseminated in the outer zone of some confused trace, may leave the way open for reasonable doubt.

All the different writers warn their readers to use the utmost care in making these comparisons. Galton states "that the number of patterns that can be promptly distinguished from one another is not large," and an American writer sums up the matter concisely as follows: "In the end it is the microscopic identity of the ridge characteristics (Galton's minutiæ) that settles the question. I have seen prints which on survey one would almost swear his life away were from the same individual, but put a glass on them, and presto, change, their differences are self evident."

These references referred to inked imprints, and if such careful examination is required as suggested by them for the inked imprints, we should be all the more careful in deciding on the identity of two imprints, one being that of an accused person, and the other an accidental impression found at the scene of a crime.

The methods of developing chance impressions found at the scene of crime, as used by the authorities at New Scotland Yard, are described in detail in the manual by Sir Edward Richard Henry, the Commissioner at that place.* With the especial permission of this author these methods are quoted here. Following this are given the details of seven representative cases, also from Scotland Yard, illustrated by photographs from there, loaned the authors by Sir E. R. Henry. These latter are undoubtedly the finest collection of the kind anywhere available.

Finger Prints found at the scene of Crime; How to Photograph and Prepare Exhibits for Production in Court. [From Henry, E. R., Classification, etc., pp. 105–110.]

"Chief Inspector Charles Collins, of the New Scotland Yard Finger Print Department, has prepared the following note which explains the method adopted in London:

"Evidence as to the identification of persons by means of finger prints, when given by competent witnesses, is accepted in Criminal Courts.

"Crime investigators should know the method by which finger prints are compared for the purpose of deciding questions of identity so that,

*Classification and Uses of Finger Prints; Fourth Edition. By Sir E. R. Henry, the Commissioner, New Scotland Yard, London.

with the aid of a reading glass, they can readily determine whether or not any particular impression possesses sufficient clearly defined characteristic detail for the purpose of fixing identity.

"Any article with a smooth surface is likely to retain imprints of value if touched. Finger prints on rough surfaces are, as a rule, of little use.

"Latent impressions can be developed with the aid of powders. If the marks are on blades of knives, plated goods, or on surfaces of a dark nature, 'Grey' powder (mercury and chalk as sold commercially by chemists) is used. If the impressions are on paper or on surfaces of a light color, graphite or lampblack will develop them. These powders ought to be used sparingly with a fine camel hair brush. All superfluous powder must be blown or brushed away.

"Unless the prints are latent, powder should not be used at the time of discovery by the Investigating Officer, as it sometimes happens that the powder reduces the area available for comparison by obscuring some of the characteristic detail. It is always possible for a skilful photographer to obtain a satisfactory photograph without the use of powder when the detail is discernible, though faint.

"When finger prints are on a part of a broken window, the remaining pieces should be preserved so that they might, if necessary, be fitted together, thus supplying evidence as to a particular piece being part of the window broken. Similar precaution should be taken in other instances, if considered necessary.

"In all cases where finger prints are found at the scene of a crime, the officer should endeavor to ascertain whether or not they are the prints of any person residing in the house, or those of a police officer or other person who may have arrived earlier on the scene.

"It should be distinctly understood that finger marks which do not disclose clearly defined detail when viewed through a reading glass are generally found to be useless when photographed.

"At New Scotland Yard much care and thought has been given to the photographing of finger marks, and as a result efficient appliances have been installed. They include a large camera with sufficient bellows extension to enable prints to be enlarged six diameters, two powerful electric arc lamps which, by means of overhead rails, can be placed in any position; and an enlarging lantern capable of enlarging a finger print sixty diameters.

"Finger perspiration marks on a piece of glass are photographed by placing the glass between the jaws of a small vice. The vice has a fitting attached which permits of its sliding up or down a metal rod. This metal rod has a heavy base to keep it steady. A thumbscrew is fitted so that the vice can be fixed to the rod at any height. A box about 18 inches deep of cross section 6 inches square, lined with black velvet, is

placed on its side with the open end immediately behind the finger mark. The rays of light from the lamps are not permitted to reach the far end of the interior of the box, thus ensuring a dead black background. The lights (one on each side of the lens) are arranged in such position that the ridge lines when focussed on the screen of the camera will appear light on a dark ground, a second plate has to be made from the first by contact in the manner one would make a lantern plate. The printing is done from the second plate. The first plate when placed in the dark slide before it is exposed is reversed, that is to say, the film side is away from the lens. If this is not done, when printing from the plate, left will appear for right in the finished print, *e. g.*, B appearing ᗺ. Conversely, if the side of the glass on which the finger impression appears is turned away from the lens the first plate is not reversed.

"Finger perspiration marks on blades of knives or on plated goods are photographed in a similar manner, but the velvet lined box is not needed. The lighting is sometimes difficult since the article must be placed and lighted in such a way that the impression will appear on the screen light on a dark ground. A little patience is rewarded by obtaining the desired result.

"Similar imprints on glass bottles and tumblers are photographed by the preceding method, but the bottles are filled with a black or dark red fluid to get the necessary contrast. Tumblers can be filled with a similar liquid when the marks are on the outside of the glass, but, as a rule, better results are obtained by placing a piece of dead black paper in contact with the whole of the inside surface of the vessel with the exception of that part covered by the finger print. Another sheet of this paper prevents light from entering the top.

"The convexity of bottles, etc., is sometimes the cause of reflections appearing over a part of the area covered by the finger impression. This is removed by altering the position of the lamps.

"When finger prints are found on the smooth side of corrugated glass, the numerous reflections are removed by filling the uneven surface with black printing ink.

"The ridges of fingers when impressed heavily on a candle create furrows similar in pattern to those of the ridges. Before being photographed such imprints are treated in the following manner: The impression is covered with printing ink, superfluous ink being afterwards removed until only that in the furrows remain. This is a similar process to that adopted by printers when preparing an engraved name plate for press.

"Finger marks in blood or dark impressions on a light surface are photographed as of black on a white surface.

"It sometimes happens that when a finger covered with a liquid

such as blood is impressed heavily, the pattern left indicates that of the furrows, not the ridges. If on comparison this is found to be the case a photograph showing the true sequence can be obtained by reversing the first plate and making a second by contact.

"Slow plates and a developer likely to produce maximum contrast should be used.

"It is not possible to give definite information concerning the exposure of plates, so many factors have to be considered. When photographing a faint mark illuminated by two arc lamps with slow plates,

FIGURE 86. Photographic enlargement of a chance impression found on a window pane. (From Scotland Yard, London.)

F 22 stop and enlarging six diameters, twenty to thirty minutes exposure is given.

"It is not suggested that these hints cover the whole field of this interesting subject. Each case must be dealt with as occasion requires. It is thought, however, that they may assist those possessing a good knowledge of photography who are called upon to photograph finger marks found at the scene of crime.

"Figures 86, 87, and 88 illustrate the way in which finger print exhibits are prepared at New Scotland Yard for production in Court. The characteristics, such as bifurcations, abruptly terminating ridges, or any

other noticeable peculiarities, are marked with red ink and numbered as shown.

"The exhibits are enlarged six diameters. A sufficient number, usually about twelve, are prepared for distribution amongst the Judge, the Jury, and Counsel. A few unmarked copies are always available in case they might be required."

The following seven cases, furnished by Scotland Yard, illustrate the method just described. They vary in details sufficiently to embrace all

FIGURE 87. Photographic enlargement of the pattern on the left index finger of a prisoner, J. H. Wheeldon. Compare with the accidental impression on the window pane in the preceding figure, and check up the 28 points of identity.

the usual conditions, such as the surfaces upon which records are made, various types of patterns, degree of perfection of the prints, and so on.

1. The last three figures, 86, 87, and 88, used to illustrate the method, represent the left index pattern of J. H. Wheeldon. The chance impression, Figure 86, was found on a window pane, and is an Ulnar Loop with a ridge count of 14. As this was on glass, it was developed with gray powder, and then a reversed plate was made before printing the photograph. The same may be said of the other specimens in this collection which were found upon glass.

Figure 87 was taken from the left index of the accused, and shows 28 points of identity with the chance impression. These are brought out in detail in the outline drawing of this finger pattern shown in the next figure (Figure 88).

2. Figures 89 and 90 show the left index pattern of George Brown. The first is a chance impression left upon glass; the second is a print, taken from the finger. The pattern is a Radial Loop, and has a high

FIGURE 88. Sketch showing the ridge characteristics of the previous print, to assist in the comparison. Compare together Figures 86, 87, and 88.

ridge count, but as the delta is not shown, the actual count cannot be determined with any degree of exactness. There are 14 points of identity.

3. Figures 91 and 92 are the prints of the right index of William Simpson, who broke into a window on the second floor of the London City Mission. The caretaker was aroused by the police, who saw that the window was broken, and it was found that the premises had been easily entered from the adjoining building. The police noticed a finger print on a piece of glass from the broken window and took it to the Finger Print Department, New Scotland Yard. This finger print was found to

be that of the right index finger of William Simpson. At his trial Simpson pleaded guilty and was sentenced to twelve months hard labor. The pattern is an Inside Lateral Pocket. There are 15 points of identity.

4. Figures 93 and 94 are taken from the right thumb of George Lane; the first was developed from a mark, accidentally left on a box;

FIGURE 89. Accidental mark left on glass, enlarged 5 diameters. (From Scotland Yard, London.)

the second was a print taken by the police from the thumb in question. The first consists of two impressions of the same finger, partly overlapping.

Judging by the appearance of the ridges, where the ridge marked 17 enters the pattern, it is an Outside Whorl. In the impression there were found 18 points of identity.

5. Figures 95 and 96 show the right index of Frederick Smith, developed from a mark found on a candle, and furnishing 16 points of

identity. The pattern is a Whorl, but its tracing cannot be determined from the illustration we have.

6. Figures 98 and 99 show the print of the right little finger of one Mitchell, a burglar. Seeking to break into a certain warehouse in London he had to climb over a gate 10 feet high. Along the top of the

FIGURE 90. Print taken of the left index pattern of George Brown. Compare with the previous figure, and note the 14 points of identity. (From Scotland Yard, London.)

gate was a row of iron spikes. He successfully climbed the gate, but in his attempt to reach the ground on the inner side he placed his feet on the center cross-bar of the gate, at the same time holding one of the spikes with his right hand. While in this position he fell, and the ring worn on the right little finger caught on the spike, causing him to remain suspended in the air until his weight tore the finger from the hand. He

escaped, but the ring and the finger were found on the spike (Figure 97). The print taken of the finger was that of an Ulnar Loop with eleven ridges between the delta and the Core. Successful search was made in classification formula $\frac{1 \quad U \quad (10) \quad 11}{1 \quad U \quad (11)}$ and in consequence an arrest was soon made. It was then discovered that the prisoner had recently lost his right little finger. The reader will see at once that in making search to see if the unknown burglar was on file, only those slips having an Ulnar

FIGURE 91. Enlarged photograph of a finger mark on glass. (From Scotland Yard, London.)

Loop on the right little finger needed to be looked at, and the ridge count of eleven narrowed the search still further.

7. The circumstances of the Deptford murders are as follows: In 1905 a man and his wife were murdered in their bed at a house in Deptford, London. They were in the habit of placing their money each night in a small cash-box kept under a pillow of the bed. After the murders the cash-box was found in the bedroom broken open and the money gone. On the side of its inner tray was a faint digital mark (Figure 100), which was immediately photographed. Subsequently two brothers named Stratton were arrested on suspicion, it being known to the police that

they were in the locality at the time the murders must have been committed. Their finger prints were taken, and the right thumb print of Alfred, one of the brothers (Figure 101), was found to be identical with the mark on the cash box. No one saw either of these men go into the house or leave it. The finger print evidence not only discovered who were the authors of this crime, but furnished the evidence to convict. Later they were convicted of the murders and both were executed.

FIGURE 92. Enlarged photograph of a print of the right index finger of William Simpson. Compare with the accidental imprint shown in the preceding figure, and check up the 15 points of identity. (From Scotland Yard, London.)

These wonderful reproductions from Scotland Yard are doubtless from among the best ones that they have had to do with. It is seldom that accidental imprints are met with that are anywhere near as good as these. The authors have seen accidental imprints that were developed, where not one detail could be checked up; nevertheless they had a certain value, as they were of similar patterns to those of the accused, and prevented a claim of "Non-Identity" from being advanced.

In obtaining imprints of a suspected person to compare with some

chance impressions, after taking the bulb impressions, take a set of rolled imprints from each finger its whole length, then prints of the palms, because accidental imprints may have been made by some part of the ridged surface of the hand, other than the bulbs of the fingers. Headquarters at Boston, Mass., have photographed four digital marks of a burglar from the left index, middle, ring and little fingers, made by dirty

FIGURE 93. Enlarged photograph of two marks of the same finger, slightly overlaping, found on a box. (From Scotland Yard, London.)

fingers on white painted woodwork, and under the circumstances they are very clear and distinct (Figure 102).

At one time one of the authors discovered a faint ridge imprint in dried blood on the black handle of a razor, that had escaped observation for four months after a certain murder. Some thirteen months later an expert photographer succeeded in obtaining a photograph by using a vertical camera, with Wratten and Wainwright pan-chromatic plates and a Red A filter. The impression was irregular in shape, and measured about

11mm x 5mm. The photograph was made in daylight and under the circumstances was a remarkable success (Figure 103). In obtaining photographs of accidental imprints, the most expert photographer that can be found should be employed, as it will be the cheapest in the end. A word of caution: all accidental imprints before and after developing *should be protected from friction,* as many such are spoiled by failing to observe

FIGURE 94. Enlarged imprint of the right thumb of George Lane. Compare with the marks on the box, shown in the preceding figure, and check up the 18 points of identity. (From Scotland Yard.)

this common sense precaution. The surest method to preserve such impressions is to spray them with a shellac fixative immediately after development, exactly as artists treat crayon drawings. The proper fixative for this purpose, together with a sprayer with which to distribute it, may be obtained at any art store.

The authors have made reversed photographs by taking enlargements printed on single thickness of photograph paper, the ridges being shown

by white lines, and, using such photographs as negatives, placing the sensitized paper back of the paper negative, the sensitized surface in contact with the back of the photograph that is to be reversed. In making

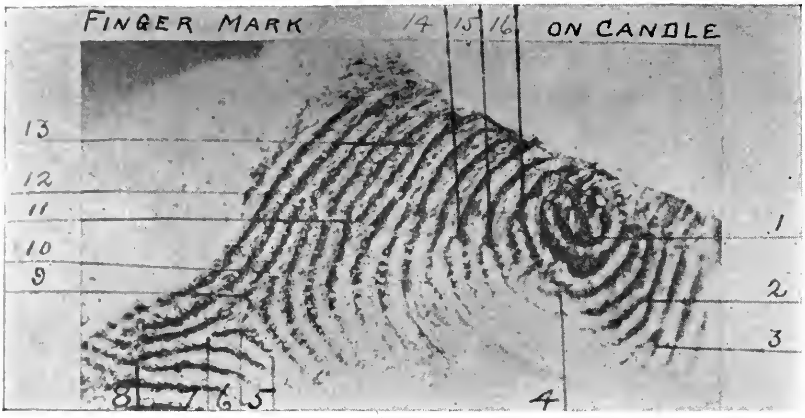


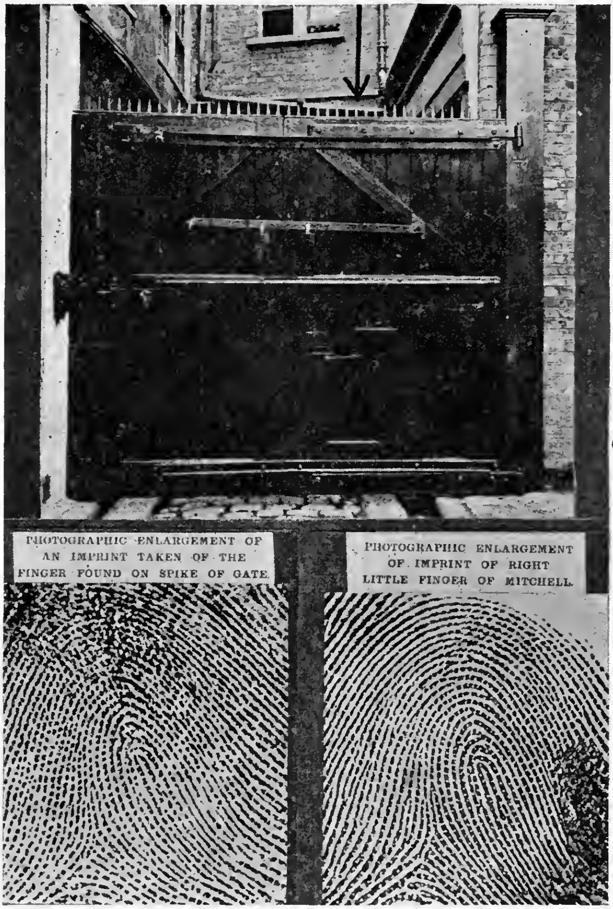
FIGURE 95. Photograph of a finger mark, found on a candle, enlarged 5 diameters. (From Scotland Yard, London.)

FIGURE 96. Finger print from the right index finger of Frederick Smith, enlarged 5 diameters. Compare with the accidental mark from the candle, above this, and check up the 16 points of identity. (From Scotland Yard.)

such reversals by daylight there is no trouble in printing through the paper negative. Engineering houses, and blue and black print operators, have a regular negative paper, very thin, which they use in making duplicate sets of engineering drawings, etc.

Similar to the seven cases reported from New Scotland Yard are numerous ones from France, but the limits of this chapter prevent any extended reference to them. Two, however, are of such importance that a brief mention of them must be given.

1. *The Scheffer case.* A servant was murdered in the office of a



FIGURES 97–99. In the upper figure (Figure 97) is shown the ten-foot gate where the right little finger was found. This was held in place on the spike indicated by the arrow by means of a finger ring, which was caught over the spike. The left lower figure (Figure 98) shows the print taken from the amputated finger, and the right, lower figure (Figure 99) shows the print of the right little finger of Mitchell, the burglar, on file at the time in Scotland Yard. (From Scotland Yard.)

dentist on the 17th of October, 1902, and M. Bertillon found the imprints of four bloody fingers on a window pane, thumb, index, middle and ring fingers. These he photographed, and after a patient research in the collection of prints, he identified these as having been made by an old offender

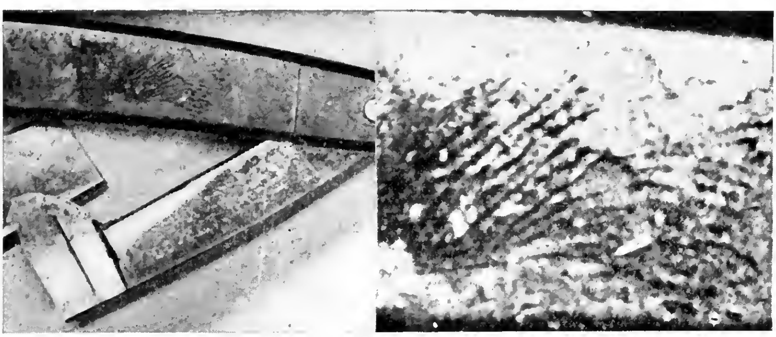
FIGURE 100. Photographic enlargement of a finger mark on a cash box. Associated with the Deptford murder. (From Scotland Yard.)

FIGURE 101. Photographic enlargement of the right thumb of Alfred Stratton, who, with his brother, was hanged for the Deptford murder in 1905 in London. (From Scotland Yard.)

named Scheffer: who confessed that he committed the crime. This was one of the earliest cases on record of the discovery of the author of a crime by imprints left by him at the place where the crime was committed.

FIGURE 102. Accidental impressions of the four dirty fingers of a left hand on white woodwork. To bring all four of the finger prints into the photograph the impression of the little finger was cut apart and aligned with the others. (From Boston, Mass.)

2. *The Mayor case.* A murder was committed in the City of Lyons, and there was no clue except a finger mark on a broken glass bottle that was used in committing the murder. This was developed by M. Edmond Locard, the Director of the Police Laboratory there, and was found to



a b

Figure 103 *a*. Photograph of a section of the razor with which Henry W. Ward was killed at New Haven Jc., Vt., Dec. 9, 1912. The handle of the razor is black, and bloody finger marks are shown white in the photograph.
Figure 103 *b*. The bloody finger marks enlarged 4 diameters.

be from the left ring finger of an old offender named Mayor. The imprint showed the whole of the bulb and about half of the second phalange of the finger in question. The imprint was studied and carefully compared with a print from the same finger of Mayor, and there were identified 82 points of similarity between the two (Figures 104 and 105).

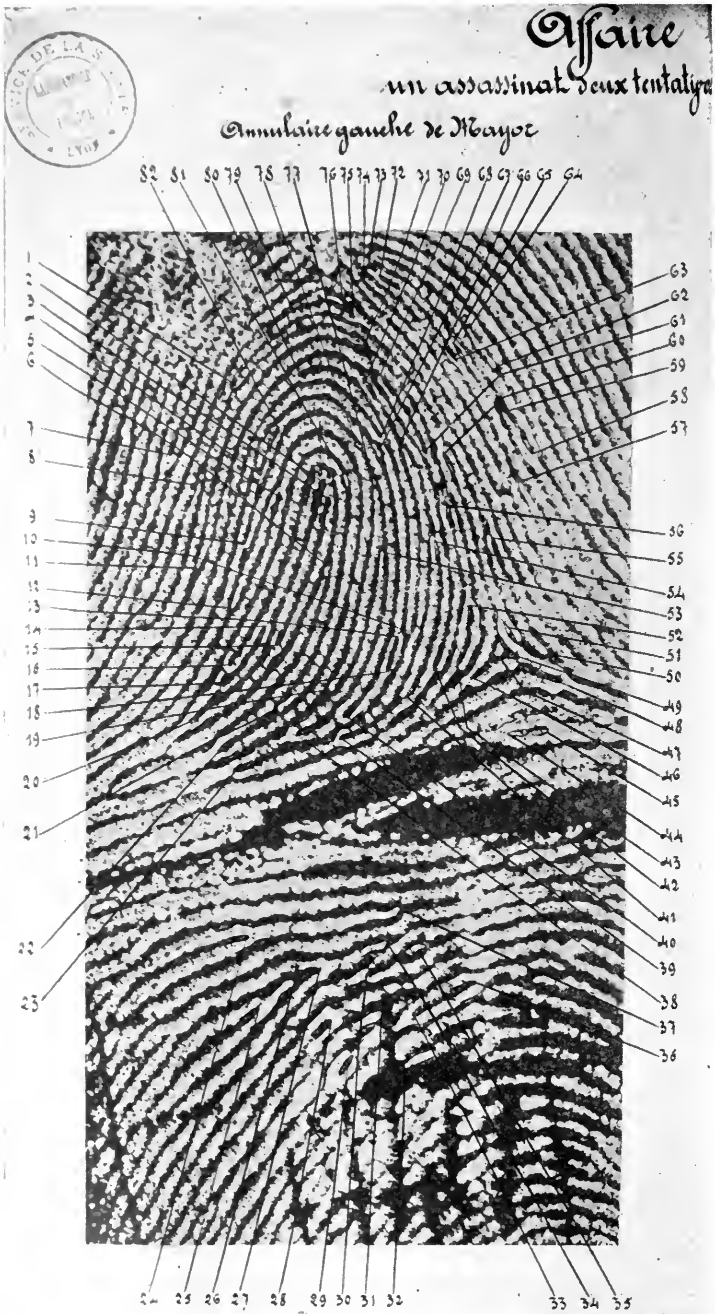


FIGURE 104. Impression of the left ring finger of Mayor, the assassin, taken directly from the finger of the man.

Figure 105. Enlargement from an accidental imprint on the neck of a br ken glass bottle. This is identified as the same as Fig. 104, by 82 points of identity.

A long list, similar to the Scheffer and Mayor cases, has been reported from France, equally interesting and of equal value with the two just mentioned. In Germany there are numerous police laboratories, not surpassed anywhere, with many interesting cases reported. Belgium, Switzerland, Italy, Argentina, Spain, all find uses for this incomparable method of proof.

In the United States there are cases of the same kind, in number so great as to cause embarrassment to the authors as to which should be

FIGURE 106. Plain impression of the four fingers of the left hand of Thomas Jennings, in the possession of the Police of Chicago.

selected for illustration. Out of this great number the following cases have been chosen:

1. *The Case of Thomas Jennings.* Up to December, 1915 the most important case in the United States, that finger prints have entered into, was undoubtedly that of Thomas Jennings, a negro, who was hanged February 16, 1912, at Chicago, Illinois, for the murder of Clarence B. Hiller. The victim was killed in his own home, 1837 W. 104th St. in that city. The murder was committed by shooting about 2.35 A. M., September 19, 1910, and about twenty minutes later a colored man in a high state of excitement was arrested some three-quarters of a mile from the place of the murder. The arresting officers had not then heard of the homicide; the suspicious appearance of the man was what caused his arrest. On his person was a fully loaded 38 caliber revolver, showing signs of having been recently discharged. The prisoner was an ex-convict, out on parole from the peniten-

tiary, having previously been convicted of many cases of burglary. Before he was sent to prison his finger prints had been taken, and again after this last arrest (Figure 106). Mr. Hiller was shot with bullets of 38 caliber, after

FIGURE 107. Impressions of the left index, middle, ring, and little fingers, found on the newly painted rail of the porch at the Hiller home after the murder of Mr. Hiller. Natural size.

rolling down the front stairs grappling with the unknown burglar. Entrance was gained through a rear window and the murderer escaped through a front window. The Hiller home had been recently painted, a porch in the rear

FIGURE 108. Diagrammatic drawing of Fig. 106, but with the points of identity with the porch rail impression marked; 33 in all.

having been finished about 36 hours before the shooting. During the day after the murder, Captain Michael Evans and his son, William M. Evans, discovered the imprints of the left index, left middle, left ring and left little

fingers of some person on the newly painted porch rail. That part of the rail was sawed out, taken to Police Headquarters and an enlarged photograph was made of the impressions thereon (Figure 107). An enlarged photograph was also made of the prints from the corresponding fingers of the accused (Figure 106), and from this enlarged photograph of Jennings' finger prints a diagramatic drawing of the same size was made. (Figure 108.) The left index finger of Jennings was a Whorl, the remaining three fingers being Ulnar Loops. The same class of patterns were found in the corresponding impressions on the porch rail. In checking up the characteristic details from these impressions, the experts found 33 points of identity in the impressions from the porch rail that corresponded with those of the accused. This correspondence alone would furnish absolute identity, even in the absence of all other proofs.

The Chicago police had in addition built a strong case of circumstantial evidence around the accused; although it is doubtful if by that alone a verdict of guilty could have been obtained. At the time of the trial the attorneys for Jennings objected to the introduction of the finger-print evidence, the principal objection being that he "was compelled to give his prints to the police in violation of his rights." The jury found Jennings guilty on the first ballot, eleven were for capital punishment and one for imprisonment for life. On the third ballot the jury were unanimous for capital punishment, and one of the jurymen was reported as saying, "*It was the finger prints and the finger prints alone that convinced us of Jennings' guilt.*"

The case was taken to the Supreme Court of Illinois, who found, in an extended review of the case, that no error had been made, and in part said as follows: "No one of these circumstances, considered alone, would be conclusive of guilt, but when all the facts and circumstances introduced in evidence are considered together, the jury were justified in believing that a verdict of guilty should follow as a logical sequence." The members of the Court were disposed to hold, "*That there is a scientific basis for the system of finger-print identification, and that the Courts are justified in admitting this class of evidence.*"

In the possession of the authors are editorials from two different newspapers, each having a large circulation and great influence. Both editorials concerned this case of Thomas Jennings. One is headed "An Outrageous Conviction," the other one headed "Fancy Detective Work." In all charity for the editorial writers, the authors can only suggest that the articles were written by men not thoroughly familiar with the subject.

2. *The Case of Charles Crispi.* The newspapers of New York City have recorded two cases of great interest here. The first is that of the burglar Charles Crispi, who took out a pane of glass from a door, placed it carefully aside, reached in, and unlocked the door. Crispi was so careful

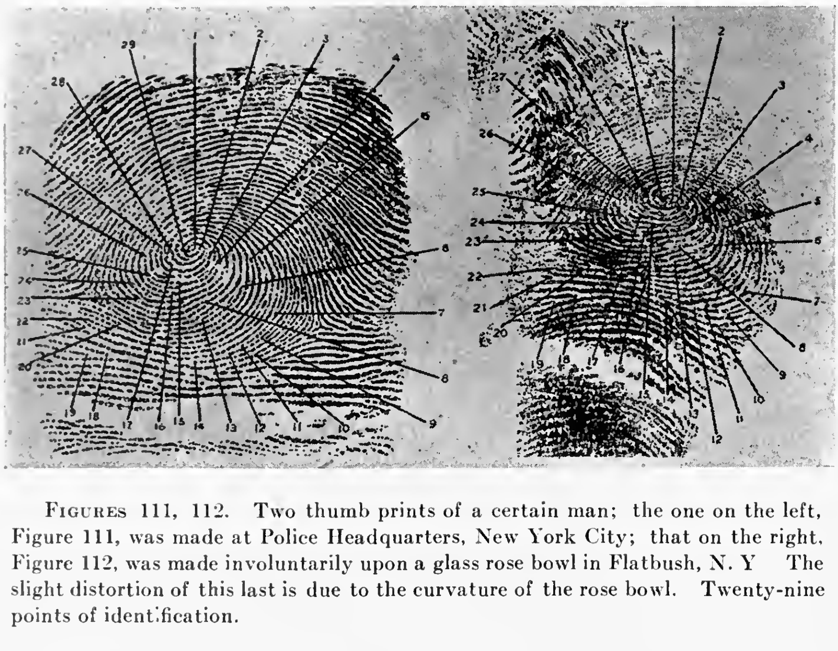
in handling this pane of glass that he left finger marks upon it. After one of these was developed (Figure 110) an officer at Headquarters found its duplicate in the files (Figure 109), and Crispi was arrested for the crime. At the trial a demonstration was made in the Court Room, and Crispi, realizing that he had made marks on the glass that no other man in the world could have made, confessed his guilt then and there, upon being questioned by the presiding judge. This burglary was committed February 21, 1911, at 171 Wooster St. Crispi's trial came later, and on the

FIGURES 109, 110. Two finger prints made by the same criminal, Charles Crispi. Figure 109 (on the left) was made at Police Headquarters, New York City, and Figure 110 (on the right) was made involuntarily upon a piece of glass. There are 16 points of identity.

19th of May, 1911, Judge Rosalsky sentenced Crispi to six months in the penitentiary.

3. *The Print in the Rose Bowl.* The case of the "Rose Bowl Burglar" is still more interesting. There was a burglary committed in Brooklyn by unknown burglars, and a heavy cut glass rose bowl had been moved by one of them. On the smooth surface of the inside of the bowl was found an imprint (Figure 112), thought to be that of a thumb, but a search of the files at Headquarters failed to find its duplicate. Some months later there was a burglary in New York City, in which a woman was killed, and one of the burglars was shot and another captured. Both were finger-printed, and the injured burglar declared that this was his first offence, that he had been led into it by his companion. Search in the files failed to find duplicates of his

prints, and the officials were about ready to believe his story of a first offence, when it flashed into the mind of the investigating officer, that there was something very familiar about one of his thumb prints (Figure 111), and that it resembled the imprint on the inside of the rose bowl that had been examined some months before. The officer was soon at the bedside of the wounded burglar, and asked him why he failed to take the rose bowl away in that burglary in Brooklyn some months before. Taken by surprise the burglar blurted out, "It was too heavy." The most interesting thing about this case was the ability of the officer to remember the imprint that he had not seen for some time, on seeing its duplicate; it is all



FIGURES 111, 112. Two thumb prints of a certain man; the one on the left, Figure 111, was made at Police Headquarters, New York City; that on the right, Figure 112, was made involuntarily upon a glass rose bowl in Flatbush, N. Y The slight distortion of this last is due to the curvature of the rose bowl. Twenty-nine points of identification.

the more wonderful when it is considered that the photograph of the imprint from the rose bowl was considerably distorted owing to the interior of the bowl being concave. This case is an illustration of the fact that an expert comes to remember the peculiarities of a finger print just the same as he remembers the peculiarities of a face. Both this and the last are illustrations of that interesting class of cases where the authors of the crimes were discovered by the sole initiative of the Police Bureau of Identification.

4. *The "Axe Man" Burglar.* A most interesting case happened in Somerville, Mass., in the fall of 1913. There had been many breaks made in a crude but effectual manner, where the unknown burglar would break in

a door with an axe. Crude as the methods were, there was no clue until one morning Captain Eugene A. Carter found the imprint of the bulb of a left index finger, together with a part of the left middle finger, on a window pane. He immediately developed these marks with gray powder, had an enlarged photograph made, and from that a reversed photograph was made to show the ridge lines in black (Figure 113). This was sent to Mr. R. C.

FIGURE 113. Enlargement of a chance impression made by the "Axe Man Burglar" upon a pane of glass in Somerville, Mass. Developed by Captain Carter of the Somerville, Mass., Police.

Hill, in charge of the Massachusetts State Bureau of Criminal Identification at the State House in Boston. On October 30, 1913, after many weeks of disappointing search, although aided by suggestions from the Somerville Police Department, Mr. Hill was fortunate in finding a duplicate (Figure 114). The unknown burglar was a young fellow well known in Somerville, and having relatives living there. Circulars with photographs and duplicates of his finger prints were sent broadcast, and not long after the young fellow, in total ignorance of the fact that the Police knew of his crimes, returned to Somerville. He was arrested December

18, 1913, soon after his return. He confessed and informed the authorities who the receiver of the stolen property was. The young fellow on a later date was sentenced to 30 months in jail.

Too much credit cannot be given to Captain Carter in the first instance for his promptness, and to Mr. Hill for the long tiresome search, that finally resulted in success. This criminal, from the methods used, was

FIGURE 114. Print of the left index finger of the "Axe man burglar." Mr. R. C. Hill of the Massachusetts State Bureau of Identification discovered the identity of this print with the chance impression from Somerville, just figured (Figure 113), using only the small area included within the line.

given the name of the "Axe Man Burglar" by the police, before his identity became known.

5. *A Burglary at Portland, Me.* In the city of Portland, Me., in the fall of 1913, a burglary was committed. The burglar left a rather fragmentary digital impression on a window pane. This was developed by Mr. Herman A. Haskell of the Bureau of Identification of that place, and after a long search the duplicate was found, and the man arrested. Upon making the arrest some of the stolen property was found in his possession.

This is one of the best illustrations known to the authors, of discovering the author of a crime by the sole initiative of the Police Identification Bureau.

6. *Proving an Alibi by Means of Finger Prints.* The two following clearly show how the innocent are protected by the comparison of impressions found at the scene of the crime.

In the year 1911, at Colorado Springs, one man, two women, and two children were killed with an axe. The murderer left bloody finger prints on the handle of this weapon. The husband of one of the women was arrested for the crime, but a comparison of his finger prints with those on the axe-handle showed so great a difference that he was immediately released from custody.

7. *Finger Marks on a Lamp Chimney; Another Alibi.* In Winnebago, Ills., a few years ago, Mrs. Margaret Griffin was murdered in her own home. The murderer left finger marks on the door, and also on a lamp chimney in the house. A neighbor, William Reilly, who went to Chicago soon after the murder, was arrested for the crime, but a comparison of his finger prints with those left on the scene of the crime showed the two to be entirely dissimilar, and Reilly was released from custody.

It is very likely that, in the last two illustrations, the two murderers had very different types of finger patterns from those of the men upon whom suspicion first fell; yet, even though the prints had been strikingly similar to the naked eye, the result would have been the same, although the innocent suspects could not expect to have their innocence proven so easily, or their discharge to occur so promptly. The microscopic agreement of the ridge details is what furnishes proof of identity, or of non-identity, rather than a general similarity of patterns, and for this time and patience are required.

The examples here cited are necessarily but few, taken from here and there to illustrate the principles. A careful study, embracing the important cases of any one of our larger cities, like Boston, New York, Chicago, or Philadelphia, would require each a long chapter.

CHAPTER VIII

POROSCOPY; THE USE OF SWEAT-PORES IN IDENTIFICATION.

"*Postremum examinanda occurrit manus, in cujus vola elatæ quædam rugæ diversas figuras describunt; in extremo tamen digitorum apice spiraliter ductæ, si microscopio perquirantur, patientia sudoris ora per medium protracti dorsi exhibent.*"* — *Marcello Malpighi; De externo tactus organo, etc., London, 1686.*

"*Il est en effet établi que les traces des orifices sudoripares constituent dans l'empreinte digitale des repères qui offrent les mêmes garanties que les points caracteristiques (bifurcations, îlots, naissance de lignes) considérés jusqu'á présent. Les pores, toujours identiques à eux-mêmes sur un sujet donné, ne se modifient ni par l'âge, ni par l'usure, ni par les phlogoses; ils sont differents d'un sujet á l'autre par leurs dimensions, par leur forme, par leur position relativement á l'axe de la crête, par leur nombre pour une unité de longueur donnée. Ils sont donc un complément précieux de la preuve dactyloscopique: ils peuvent y supplier pour les empreintes trés fragmentaires.*" † — *Edmond Locard, La Preuve Judiciaire par les Empreintes digitales, Lyons, 1914, p. 10.*

THUS far our attention has been directed mainly to the study of printed impressions of the friction-skin surface, as they appear on paper. For the still more detailed study that may be necessary in the identification of only a few ridges, with, perhaps, no pattern at all (for even this is at times possible), the attention must be directed to the actual skin surface, and its details followed by the aid of the microscope.

As a first lesson the reader should examine his own fingers with the aid of a pocket magnifier having a power of 5 to 7 diameters. The surface to be examined should be held so that the light strikes obliquely across

*We come at last to the examination of the hand, in the palm of which certain raised ridges describe various figures; those, moreover, which are arranged spirally at the ends of the fingers, when examined with the microscope, display the open mouths of sweat-glands, arranged in a line along the middle. (Free translation.)

† It is in fact established that the traces of the sweat pores in the finger print constitute points of identification that offer the same guarantees as do the characteristic points considered up to the present (forks, ends, islands). The pores, always the same in a given subject, are modified by neither age, use, nor disease; they differ from one subject to another in their form, their size, their position relative to the axis of the ridge, and their number in a unit of length. They are then a valuable adjunct to the dactyloscopic proof; they can even supplement it in the case of very fragmentary imprints.

it, thus bringing out the relief by casting shadows, while the observer should be so placed that the light comes from behind him, so that it will not shine in his eyes.

Thus seen, the surface of the friction-skin will appear something like corduroy velvet, consisting of a series of rounded ridges or half-cylinders, lying in direct contact with one another and separated by line-like furrows

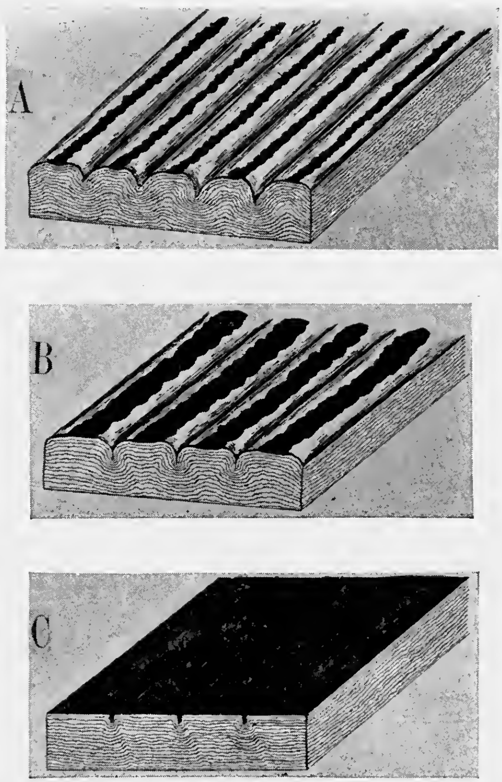


FIGURE 115. Diagrams showing the principles involved in making a print of friction ridges. In *A* the pressure is slight, and the inked surface forms a very narrow band along the crests of the ridges. *B* shows about the right amount of pressure, which flattens fully half of the surface of the ridge, and makes the inked strips about as wide as the intervals. In *C* the pressure has been so great that the ridges are so flattened and squeezed together as to form a continuous inked surface, the intervals being marked simply by narrow lines, blacker than the rest. (*Drawn by Alice Miriam Hudson*)

of no appreciable breadth. These long, semi-cylindrical ridges are like elastic cushions, and become more or less flattened by varying degrees of pressure, but regain their original shape the instant the pressure is removed.

When, now, these cushions are pressed against an inked plate of glass or cardboard, the ridges become more or less covered with ink in proportion to the pressure employed. If but lightly touched, the ink becomes deposited upon only the highest crests of the ridges (Figure 115, A); if

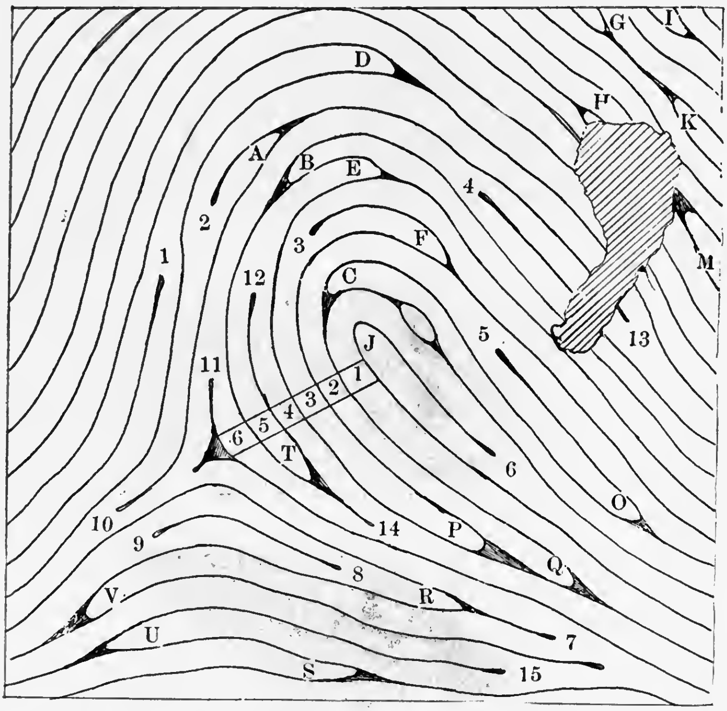


FIGURE 116. Pattern of right middle finger of "Bangor Billy," showing the appearance of the actual ridges as seen upon the finger. Compare with Figure 126 of the next chapter.

the pressure is a little greater, more of the breadth of each cushion becomes inked (Figure 115, B), while a large amount of pressure so flattens the cushions that the flattened surfaces come in contact with one another, forming an almost continuous flat surface, which receives the ink like an unbroken plane, save for the thin lines between the ridges, which hold a little more ink than the rest (Figure 115, C). In printing these upon white paper, and using always as much pressure as upon the inked surface, the first case (A) leaves a set of narrow lines, the second (B) a series of broad lines, with white bands of about the same breadth between them,

and the third (C) a continuous black surface, traversed by parallel lines still blacker, where the furrows hold the extra ink, the principle being similar to the use of an engraved steel plate.

The mechanical principles involved in this brief study will not only

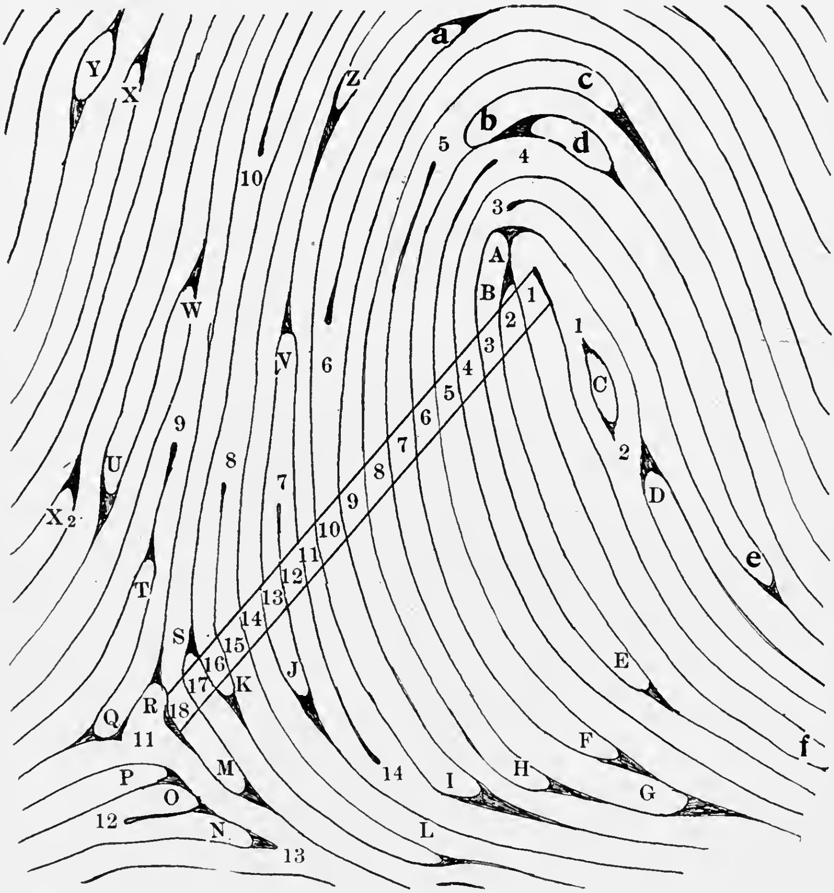


FIGURE 117. Pattern of the right middle finger of J. C., showing the appearance of the actual ridges, as seen upon the finger. Compare with the previous figure; also with Figure 136 of the next chapter.

show the reader why different prints, and different parts of the same print, are very different in appearance, but will demonstrate clearly that a print does not give a correct idea of the real skin surface, but only serves to locate the ridges by means of lines that run lengthwise through their highest crests. The actual ridges in a finger pattern, as they appear on the skin surface, are shown in the two figures here given (Figures 116 and

117), which give the ridge details of two similar Ulnar Loops, taken from the right middle fingers of two different men, and show the ridge counts and the separate features. Even for a finger-print expert who works all the time with prints, such drawings are hard to understand, for the lines,

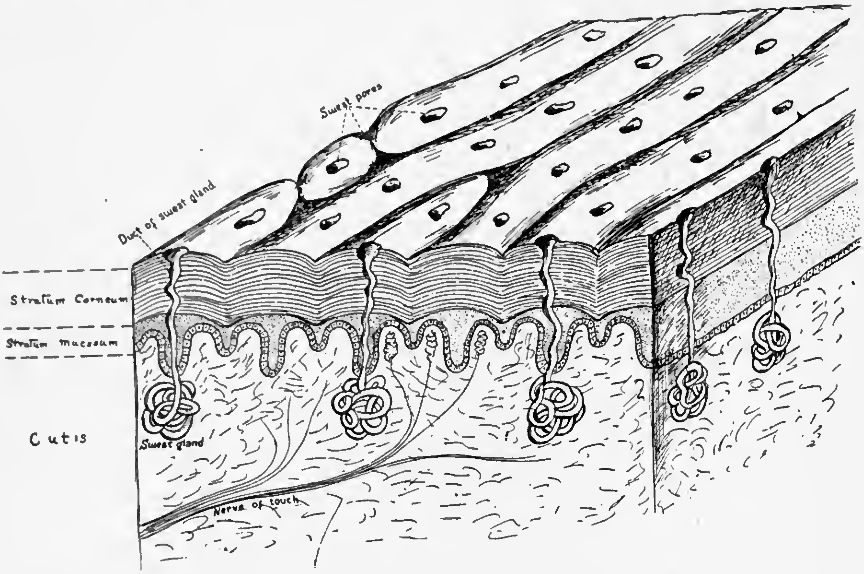


FIGURE 118. Diagram showing the microscopic structure of friction skin. On the surface are shown four and a half ridges, the one on the right represented as split longitudinally. The end of a fifth ridge projects into the field, and the first ridge on the left shows the formation of an island, resulting from an incomplete fusion of one element. The epidermis consists of two main layers, the *stratum corneum* (horny layer), covering the surface, and the *stratum mucosum* (mucous layer) beneath. This latter is folded on its under surface so as to form ridges that run lengthwise, and correspond to the surface ridges, but are twice as numerous, since deeper ridges that correspond to the middle of the surface ridges alternate with smaller ones, that correspond to the furrows above. On the right, where a surface ridge is cut along the middle, a deeper ridge of the under surface is cut lengthwise also. On the surface, sweat-pores run in single rows along the ridges, and communicate through sweat ducts with the coiled sweat glands, which lie quite below the entire epidermis in the cutis, or leather skin. Nerves of touch run up through the cutis and terminate in tactile corpuscles, the ultimate organs of touch, in the furrows between the ridges. The friction ridges themselves result from the fusion in rows of separate epidermic elements like the island shown on the left, each with a sweat gland in the center.

representing the furrows, all come in the wrong place, *i. e.*, between the ones they are accustomed to. They are, however, drawings of the actual surface of the friction-skin, and as such should be well understood.

Midway between the lines marking the furrows are found the mouths of the sweat glands, the *pores*, which lie in a longitudinal row along each

ridge, at about equal distances apart. They are left out of these pictures for the sake of clearness, but may be easily seen upon the actual skin surface by the aid of a low magnification, and can sometimes be detected by the unaided eye in the case of the larger and coarser ridges. In an exceptionally good print these openings are seen as minute white dots running along the black ridges (in Figure 92, for example), or as black dots on the white ridges when the colors are reversed (Figure 119). These mouths are the terminal ends of tubular glands of microscopic size, each of which forms a complicated coil in the deeper layer of the skin, the *cutis* or *corium*, and come up through the upper layer, the *epidermis*, as a slight spiral, perpendicular to the surface (Figure 118). The ridges, with which these pores stand in definite relation, are formed in the lower layer of the epidermis, the *stratum mucosum*, which forms them, and from here they are continually renewed as the surface becomes lost by the constant shedding of the thin flakes of the outside epidermis, the *stratum corneum*.

In the usual bruises of the surface, and in blisters, the skin that is lost is generally the stratum corneum only, underneath which the stratum mucosum, with its ridges, remains uninjured, and soon renews the outer layer, naturally in precisely the same way, ridge for ridge. A more serious injury, involving the loss of this lower mother-layer, would naturally prevent the reformation of any ridges, but such an operation would be too deep and too serious to be voluntarily undergone over as large an extent of surface as a single hand, and as it would be replaced, not by ridges, but by a new growth of cicatricial, or scar, tissue, this condition would in itself mark a man much more than would the original ridged surface. It would also destroy the sense of touch, which is located in the minute folds and papillæ of the cutis, immediately beneath the stratum mucosum, and thus render the hands practically useless. Since a complete obliteration of these identification marks would involve such a serious maiming of both hands and feet, its attempt in a desire to hide the identity cannot even be contemplated.

As seen on the surface of the skin at a low magnification the sweat pores, the "*patientia sudoris ora*" of Malpighi's description, are found to vary in so many ways that, after studying a small area for a little, certain ones of them, and certain groups, will take on an individuality as great as do the ridges which bear them; and because of this each small area may be distinguished absolutely from any other. *In fact, we have in these minute structures a set of objects upon which, notwithstanding their minuteness, the positive identification of a small patch of friction skin can be based,* and this as surely as can be done with the ridge detail studied in the last chapter. Naturally, considering the large number of sweat pores to come under consideration, more than a thousand in an average finger print, there can be no possibility of formulating and indexing them, yet, in a specific case,

where an identification hangs upon an impression in which only a few ridges may be clearly made out, it is quite possible by the study of the sweat pores present to definitely identify this fragment with a part of a known print in the possession of the investigator, and thus render certain a supposed identification.

This method of *Identification by the Sweat Pores, or Poroscopy,* has now been for some time in practical use at the Prefecture of Police at Lyons, France, at the hands of Dr. Edmond Locard, the Director. By this means he has aided many times an identification made by the usual methods, and in several cases, notably the now famous one of Boudet and Simonin, has secured a conviction by the unanswerable testimony of the sweat pores.

According to Locard, the sweat pores vary in the following ways:

1. *The size of the pores.* The size of the pores varies apparently without system, and pores of several sizes may be found near together. Locard measured the diameters of several, taken from developed impressions, which are much sharper than prints, employing the methods of microscopists, and using their unit, the *micron*, and found them to vary in diameter from 88 to 220 micra. The largest pores had thus three times the diameter and nine times the area of the smallest.*

2. *The form of the individual pore.* In form a pore may be round, or it may be elliptical, oval, square, rhomboid, or triangular. In an ordinary inked print the pores are usually more or less filled with ink, so that their actual shape is not revealed, but in an accidental impression, developed by oxide of lead or an equally good substance, and then photographed to the proper enlargement, as in the illustration here given, the individual shapes are clearly seen (Figure 122).

3. *The position of the pore on the ridge.* This is practically the most useful character, and is certainly the most conspicuous. The pores usually lie in a single row along the middle or crest of the ridge, parallel to the lateral furrows, but now and then a single pore, or a series of several of them, open on the side, occasionally almost into the furrow between the ridge and the next. Such a laterally placed pore is likely to appear in a print as an open notch, since the substance used in printing covers only the middle of the ridge, and does not include the outer margin of the lip of the pore. On this very account one must not expect to find two separate prints of the same pore to be exactly alike in this respect, as the pore may

*A *micron* (plu. *micra*) is $\frac{1}{1000}$ of a millimeter, and thus, as 25 millimeters are approximately equal to an inch, a micron is equal to $\frac{1}{25000}$ of an inch. Eighty-eight micra are, then, $\frac{88}{25000}$, or about $\frac{1}{300}$ of an inch, and 220 micra equal $\frac{220}{25000}$ or $\frac{1}{114}$ of an inch. Roughly speaking, then, the sweat pores range in diameter from $\frac{1}{300}$ to $\frac{1}{100}$ of an inch.

be open in one and closed in the other, in accordance with the breadth of the printed surface in the two.

Again, the position of the pores may differ with respect to the adjacent ones in the same row, a few being near together, followed along the same ridge by others further apart. Occasionally, too, at certain points, two pores may occur, running abreast or nearly so, across a ridge, or again three may crowd so closely together as to form a triangle. Such striking points, the form of which is easily held in the eye, form valuable characters in locating an area upon a complete print, and thus determining the identity of a fragment under consideration.

4. *The number or frequency of the pores.* This feature is characteristic of an entire print, or indeed of all the prints of a given individual, and may be calculated in two ways: (1) the average number of pores that occur on a given length of ridge, or (2) the average number found within a given area. For instance, Locard finds that the number of pores along a centimeter of ridge varies from 9 to 18, and as two and a half centimeters are almost the equivalent of an inch, this would mean 23 to 45 per inch. In the entire area shown in Figure 119, which is enlarged 7.5 diameters, there are more than 900, but in this individual the pores were larger than usual and very numerous.

We have, then, in the sweat pores, with their great individual differences, and their persistence throughout life, an invaluable series of individual features, which can be employed to advantage in cases where the record is too incomplete to show a definite pattern, or too fragmentary to make out even the ridge details with certainty. As compared with one case where definite finger patterns are left upon the premises there are dozens where only the marks of a few ridges can be obtained, and these often of other parts of the hand than the finger bulbs. Such fragments may be often identified by poroscopy, if we have for comparison the prints of the corresponding parts of the hands of suspected persons. Nor is this search as great an undertaking or as arduous as one would think. In the first place a careful study of the objects handled will suggest the parts of the hand which would come most naturally into contact with those places where the impressions are left, perhaps the bulb or middle phalange of the index finger, or the outer, or ulnar, cushion of the palm. Such a preliminary diagnosis greatly assists the search, as it directs the attention to certain limited areas which are to be studied first. The investigator should naturally be in possession of prints, or, still better, developed impressions, of these parts taken from the hands of the suspected party or parties, and enlarge both these and the traces found to about the magnification shown in Figure 122; that is, 40 diameters, for easy comparison. In starting it is well to select a characteristic group of pores, not too many to remember readily, and then, with the picture of these in

mind, to search over the likely places of the more complete print for a duplicate group. When noted, compare the surrounding pores, and eventually test the entire fragment under inspection. Mathematically the positive establishment of some 20 to 40 pores should establish a complete identity for the two duplicate areas, yet, where a much larger number of details is obtainable, one should use his full opportunities, and make the comparison cover some hundreds of pores, or, if so many are not available, all there are.

Such a proof, which, in the case of an ordinary chance impression may be based upon hundreds or even thousands of different points of identity, incalculably strengthens any proof brought forward by the use of the ridge details, and when shown up by the use of enlarged photographs, presents an overwhelming piece of evidence to any judge or jury. It was precisely this corroborative use of poroscopy which Locard made at Lyons in 1912, in the now classic case of Boudet and Simonin, which Locard himself has described about as follows:

On June 10, 1912, the apartment of M. Chardonnet, at No. 6 Rue Centrale, was broken into, and several pieces of jewelry, together with 400 francs in money, were stolen. There was no witness, and no clue to the thieves; but a rosewood box, in which the jewelry had been kept, was literally covered with blurred finger marks. These were developed with carbonate of lead and photographed. On comparing these with the collections at headquarters, an assistant named Chambon discovered that certain of the impressions belonged to a man by the name of Boudet, who had been sentenced several times before for theft. On looking up the records it was found that Boudet habitually operated with a pal named Simonin. The two were put under arrest, and impressions of their hands, other than the finger prints, were taken. There were obtained from the prints which covered the box a fair impression of the middle phalange of the left middle finger of Boudet, and one of a small area of the left palm of Simonin. From the ridges alone, in the usual way, there were established 78 points of identity for the first and 94 for the second, yet, as the accused would not confess, the case was brought before the assizes. Here the jury was shown enlarged photographs of the regions in question, taken both from the impressions on the box and from the men themselves, developed in the same way. In addition to the ridge details emphasis was laid upon the correspondence of the sweat pores, of which, in the area from Boudet's finger, there were 901 separate pores. All of these, allowing for difference in the amount of pressure, were shown to correspond exactly; while upon the area from the palm of Simonin there were more than 2,000 such correspondences.

As a result of this demonstration, which presented such an enormous number of correspondences, the jury was convinced, and Boudet and

Simonin were each sentenced to five years of hard labor. It is to be emphasized, first, that there was absolutely nothing else than the marks on

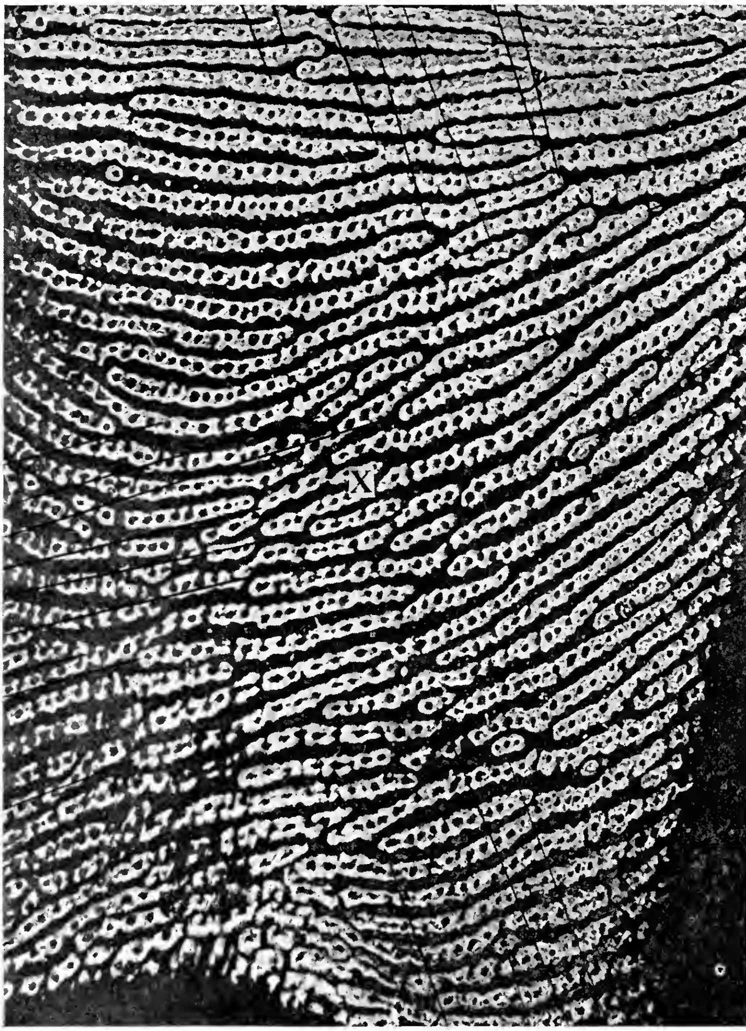


FIGURE 119. Impression of the friction skin from the middle phalange of the left middle finger of Boudet; magnified 7.5 diameters This is a photograph from an impression, developed with carbonate of lead. (Original presented the authors by M. Locard.)

the rosewood box that could be brought up against the men, and, secondly, that the box had been so much handled by both thieves that there were no distinct patterns, and but few places which were not surcharged by

overlapping impressions. Locard himself remarks that without the slightest doubt the sweat pores played the principal role in convincing the jurors, who could not deny this overwhelming mass of evidence.*

FIGURE 120. Impression found on a rosewood jewel box, developed with carbonate of lead, and photographed; X 7.5. This is surcharged with another impression over the left half, but the right half is fairly clear. (Original presented the authors by M. Locard.)

*See article by E. Locard; "Les Pores et l'identification des criminels," in *Biologica,* 2 an. No. 24, December 13, 1912. Publ. at Paris, Boul'd St. Michel 121.

As a practical illustration of sweat-pore identification we present here a series of photographs sent us by M. Locard, and taken from the material used in the above case.

The first of these (Figure 119) shows the impression of the middle phalange of Boudet's left middle finger, developed by carbonate of lead from an impression taken directly from the man himself, and magnified (originally) 15 diameters. The copy given here is reduced one half from the original. In this, as was characteristic of Boudet in general, the pores are unusually large and numerous, more than 900 in this figure. The next figure (Figure 120) is to be compared with Figure 119, and represents a chance impression taken from the surface of the rosewood jewel box. The left half of this chance impression is surcharged with a second impression, which obliterates the details of both, but the right half is sufficiently clear to allow numerous comparisons with the corresponding surface in the impression obtained directly from Boudet.

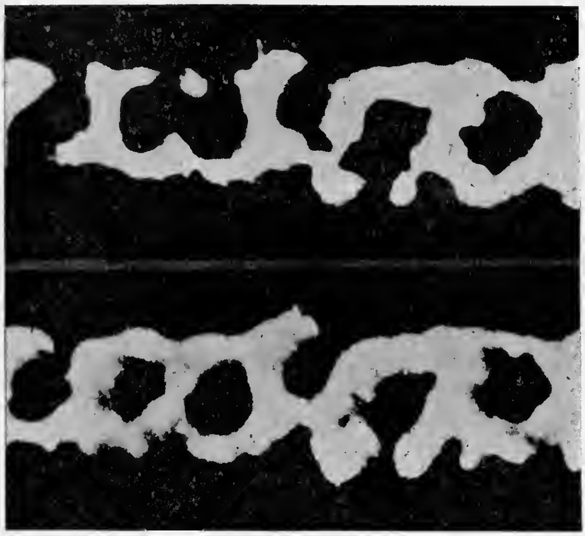
The main difficulty in making the comparison is in finding a starting point, and for this we may take the obliquely placed ridge just to the right of the letter X, in both figures some sixteen ridges down from the top, counting along the middle of the figure. In Figure 119, immediately to the right of the letter X, the ridge begins with a large triangular ridge element, or supporting unit, with a single sweat pore in its center. Between this isolated unit and the continuation of the ridge to the right is a narrow break, which is probably not a real separation, but a deeply lying sweat pore with a cross furrow that pushes the surface down so that it does not print. This is a common appearance, and naturally varies in different prints, since its printing or not depends upon the amount of pressure exerted. Beyond this again, still continuing towards the right, we find the following succession of pores:

1. A pore opening upwards.
2–3. Two round pores with entire margins.
4. A pore on the upper margin, and represented by a wide-open notch.
5–6. Two large, round pores, the first opening below by a narrow crack.

If the examination of this ridge be continued, it is seen that Pore No. 6 is followed by a large oval 7th, an elongated 8th, and so on.

It may take some little trouble at first to recognize this same ridge in the impression taken from the box (Figure 120), for the surcharge that covers the left half of the figure conceals the pointed nose of the triangular piece with which we began in the first case. Counting down as before, however, it will be found as the sixteenth ridge down from the top, just to the right of the letter X, as in the previous figure. As the pressure

was not so great as in the control print, taken for the purpose from Boudet (Figure 119) the ridges are less flattened, and more limited portions of the ridges come in contact with the paper. It is a result of this that in some cases which in the other figures show entire pores, they are here represented as either notches or complete breaks. The lip of a pore is irregular in its height, and if the pressure is but slight the contact surface touches only the higher parts, which are those along the middle of the ridge, while the sides, which are lower, do not print. Here the most conspicuous pores are the two large round ones that have run together, and also open along



FIGURES 121, 122. Portion of a ridge with six sweat pores, shown in the chance impression from the rosewood box (Figure 120), and in the impression taken directly from the left middle finger of Boudet (Figure 119). Enlarged to 42 diameters. (After Locard.)

the upper side of the ridge. These are Pores Nos. 2 and 3 of the previous count, which, in the print with greater pressure, appear as "two round complete ones." Just to the right of these is the one that opens up, followed by two large round pores, after which these two small prints come to an end.

The comparison of these six sweat pores may be followed still farther by the help of Figures 121 and 122, which show the ridge in question isolated and enlarged to 42 diameters. The upper one, Figure 121, is taken from the impression on the rosewood box; the other from the carefully made impression from Boudet, with which it is to be identified (Fig-

ure 122). This latter corresponds to the list above given, in which the same six pores are described, and it is easy here to see, reading from left to right, the "sweat pore opening upward," the "two round complete ones," the "pore on the upper margin, represented by a wide open notch," and the "two large, round pores, the first opening below by a narrow crack."

Turn now to the upper figure and by a little study the complete identity of the two will become apparent. The mouth of a sweat pore quite frequently has a cross furrow, making the lip nearest the two sides a trifle lower than the rest of the circumference, and this is why the print with the less pressure, Figure 121, shows this on both sides, continuous with the pore, and appearing as a slight break. In the corresponding pore of the lower figure, Figure 122, a little more pressure has closed up the lower furrow and left the upper one considerably narrowed. A slight increase of pressure would easily bridge this slight gap and present the mouth as a complete one.

The second and third pores, closely associated on their surface, are pressed sufficiently in the lower figure to show complete lips, but the upper figure shows more of the surface sculpture, and indicates a rather deep groove running between the two, while the isolated dot suggests the side wall that is completed by a little more pressure in the other print. Pore No. 4 differs but little in the two impressions, but the increased pressure of the lower print has obliterated the little notch in the side of the big one. Otherwise the two outlines are identical. The fifth, opening on the lower side, is modified a bit by the extra pressure, yet retains its characteristics remarkably well in both prints. It is easily identified. The same may be said for the sixth, even with its irregular contour. The modification is slight. In the same way the surrounding pores of this and the adjacent ridges were found to correspond, part for part, so that, in all, as stated above, there were 901 corresponding pores, matched in position, shape, size, and often in minute details, like Pore No. 6 of the illustration.

Some experts, in the development of a chance impression, prefer to use a black powder, to make a better comparison with a black print, and to make the matter easier for them, we give in the next figure, Figure 123, a detail of these same sweat pores with those near them, shown in black. If it is found expedient at any time to thus reverse the colors in a photographic enlargement, one may simply use single-weight photograph paper as a negative, and print through that. Use for the paper a kind that gives a strong contrast, print by daylight, and use a slow developer. Where time is to be saved it is possible to use artificial heat in drying, so that one can make a print from a previously prepared negative, develop and dry it, make a reverse print from this, and have this last ready for examination in a very few minutes.

These photographs with reversed colors show the sweat pores with remarkable clearness and are in many ways easier to interpret than the other kind. Thus, in Figure 124, which shows the first few pores of the two ridges of a fork, the variation of shape and arrangement is remarkably clear. At the upper left-hand corner is a pore that lies in a minute transverse crease, like some we have previously considered, and shows the sweat pore itself, with an opening on each side. The next one to the right on the same ridge is similar to it, but here the original surface was more irregular, and the identification of pore and creases is not so clear.

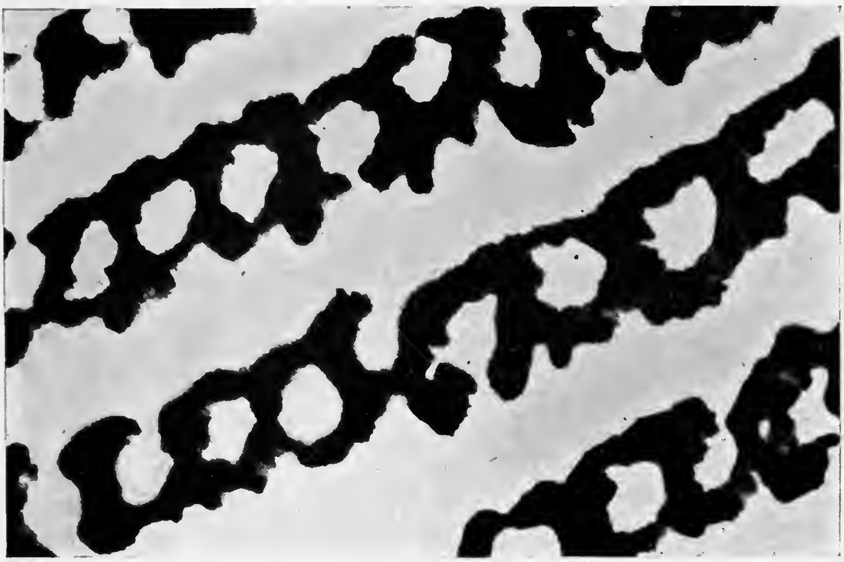


FIGURE 123. Portion of friction skin, including the ridge shown in the two previous figures, with surrounding ridges. This was taken from the left middle finger of Boudet after his arrest, but the colors have been reversed by a second printing, in the manner described in the text.

This fragment would originally measure, before enlargement, approximately 1-16th by 1-13th of an inch. The pores average probably 100 to an inch of ridge in length, or nearly so, double the number usually found in a normal subject.

Then follow three entire pores and a notch, which represents a pore placed on the side. As this laterally-placed pore faces another on the ridge above, and as the two thus open towards each other at the point where the forking occurs, it is likely that the glands, of which they form the outlets, were more or less fused below the surface, forming a compound or twin structure. Another twin pore, but placed with the components arranged lengthwise of the ridge, appears in the upper ridge.

In this connection it is important to call attention to the difference

between an *enlargement* and a *magnification*, as the two words are very different in meaning, although often used interchangeably.

When an object is *magnified*, more details appear than were seen before, and new details continue to appear as the amount of magnification increases, but in an *enlargement* the details already there are made bigger, area for area; you get no new information, but what has been already presented is larger. The face of the manager on a circus poster may be six feet across, but in it there are no more details to be seen of the texture of a face than one sees at the natural size. It is merely *enlarged*, for the

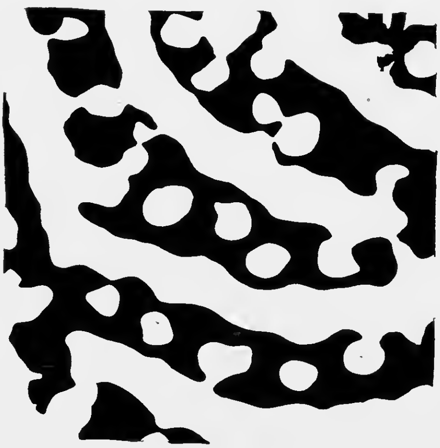


FIGURE 124. A fork, enlarged 32 diameters, illustrating the differences in size, shape, position, and number of pores, on two adjacent ridges. Notice a double pore where the ridge bifurcates at about the middle of the right side.

purpose of being seen at a distance. If a face were really to be *magnified* to that size, think of the details of the skin which would appear upon it!

Now if an ordinary print were to be magnified to, perhaps, 30 diameters, the fibers of the paper would show so distinctly that the background would look like a rough blanket; also the ink surface, with the particles of which it is composed, would resemble sandpaper. Another decidedly undesirable feature that would appear would be that the margins everywhere, where black and white areas come together, would become irregular and uncertain, and this character would increase with each power of magnification, until the prints would be impossible to use.

Naturally a lens or reading glass magnifies, and this is of value, and a decided advantage to a certain extent, perhaps up to 15 diameters;

much beyond this, however, a magnification would be disadvantageous, and we resort to enlargements.

Thus Figure 124, enlarged (not magnified) to 32 diameters, has all of its boundaries precise and definite; the black areas are smooth and featureless, and the white show no details. It is exactly right for the purpose for which it is to be used, to be shown to a jury. But no degree of enlargement can get anything more out of it. A greater enlargement can be seen farther, perhaps across a large court room, but the black areas will remain just as featureless, and the boundaries will be just as clear-cut and precise. If, on the other hand, this print had been *magnified* to this extent, the graining of the paper, the particles of the ink, and all the roughnesses of the actual surface would tend to render the boundaries less precise and the print less clear for the purposes for which we use it. Thus nothing is gained in magnifying beyond a certain point; a small *magnification*, perhaps 4 to 7 diameters, is quite enough; above this one needs only *enlargements* up to the size required to be distinctly seen. A magnification of 4 diameters is large enough for the general ridge details, when in the hands of an expert; a magnification of 7 diameters brings out each detail wonderfully and allows them all to be readily located and counted. This magnification is about right for the count of the ridge details by the method of 100 squares (see Chapter IX). It is also large enough for ordinary work before a jury. Fifteen diameters, also a magnification, is large enough for poroscopic work, but, in order to exhibit this to the court, some degree of enlargement beyond this is necessary. Enlargements of 60 to 80 diameters are large enough for any court room, unless it is required to show them at a considerable distance, when there are possibilities of enlargement to any required size.*

The facts here presented show that Poroscopy, or the study of the sweat pores, is an important branch of finger print identification, and finds its especial application in the identification of chance impressions. "It often happens that the prints left by the criminal are extremely fragmentary, and the most careful search reveals only a small area of useful traces. This may be either because the criminal has protected his hands

*The modern form of projecting and reflecting lanterns, especially when equipped with the incandescent, instead of the arc, light, is decidedly the most practical method of presenting all facts connected with ridges or pores. A small lantern, sufficiently large for the court-room, is not very expensive; it is easily transported, and enlarges to any required dimension small photographs of finger prints or impressions of other ridged surfaces. Prints made directly from fingers or the entire palm upon a thin sheet of gelatine, or plate of glass, can be thrown directly upon a screen with the same ease as with an ordinary lantern slide, and two of the same size might even be compared by superposition. We are not aware that this technique has ever been developed very far, as applied to the subject in hand, but we are confident that it will be found the best and most expeditious way of presenting the facts of friction-skin identification.

by wearing gloves, * or, more likely, because the traces have been obliterated by intruders, police or otherwise. In such cases it is absolutely necessary to renounce the finger-print proof, because it is true that there is a certain limit, beyond which proof from finger prints is merely presumption; but in all cases the digital patterns reveal a series of sweat orifices, more than a thousand to a phalange, which are unchangeable in form, in position, in size, and in number, and constitute so many definite characters which afford a powerful aid to the dactyloscopic proof, and can be relied upon independently in cases of extremely fragmentary impressions."†

Even when the public, or the police officials, have had full access to the scene of a crime, and have actually handled the objects concerned in it, and placed their fingers over the very impressions left by the perpetrators, the case is not absolutely hopeless, for, as in the double impressions involved in the Boudet-Simonin case, a few ridges may escape being surcharged; yet it is readily seen that such blunders increase tenfold the labors of the finger print expert.

At Lyons, and in many other cities of France and Germany, the finger-print expert is always the first one admitted to the scene of a crime, and all persons, including the police and those nearest interested, are excluded until he has finished his examination. Locard declares that the finger-print system is useful here in exact proportion to the discipline of the police in this matter, for where a room is invaded by friends, neighbors, policemen, and others, all traces are soon obliterated.

It is to be understood, finally, that, even though an imprint is without a pattern and of very small area, if brought out clearly the evidence from the pores alone makes it possible to establish certain identity. The main trouble, aside from direct interference, has long been, and will be for some time, that by the usual methods of development the ridges in an accidental imprint are so loaded up with powder that many times the pores cannot be seen, or, if too much is removed, the characteristic details are also lost; but the authors look ahead to the time, not far distant, when all accidental impressions will be developed by suitable chemical fumes, or by other equally delicate methods, thus reproducing the impressions exactly as they are, without the intervention of any kind of powders, so much in use to-day.

Identification by the sweat pores has been used but little up to the

*With regard to the fear sometimes expressed that criminals may cover their traces by wearing gloves, Locard calls attention to the delicate use of the fingers, and the importance of an acute touch, in the work of a burglar, work necessarily carried on in the dark, or in subdued light; that this class of men are not accustomed to wear gloves in their usual activities would make such a feat still more difficult. In Lyons, out of 1,498 cases investigated by the police, only fifteen or so were cases in which gloves were worn. Stockis of Liége has shown that even gloves are not an absolute preventive of the telltale impressions, unless all areas of the friction-skin are completely protected during the work.

†M. Edmond Locard

present time, perhaps mainly by Dr. Locard in France and by the present authors in the United States, but the suggestion that this field is still largely unexplored may induce others to experiment and investigate along these same lines. Locard says, "If the jury or magistrate hesitate because it may seem to them audacious to believe that 12-15 points are

FIGURE 125. M. Edmond Locard, Director of the Laboratory of Police, Lyons, France.

sufficient to identify an impression, they will do so no longer when they are shown the perfect accord of hundreds of pores." As an illustration we may cite the Maten case, also from Lyons, where a fragmentary imprint without details contained 200 pores, and was thereby identified as coming from the right ring finger of the accused burglar, Maten.

In a very able article on the subject of Poroscopy, published in 1914, the author, M. Locard, closes as follows:

CONCLUSION

"1. The sweat pores present the triple characteristic of perpetuity, immutability, and variety, which establishes them as a means of identification of primary importance.

"2. Identification by the comparison of pores in a striking manner confirms the evidence from finger prints, by adding to the determination of ridge details that of the visible sweat pores, the number of which is often many hundreds, and in a good impression may exceed a thousand.

"3. In most cases in which the digital or palmar impression is too fragmentary for an absolute identification by the dactyloscopic method, which requires a minimum of twelve characteristic points, the comparison of pores, providing these are discernable, will permit the attainment of positive identification."

CHAPTER IX

THE IMPOSSIBILITY OF FINDING TWO IDENTICAL FINGER PRINTS

"*Had M. Beauvais, in his search for the body of Marie, discovered a corpse corresponding in general size and appearance to the missing girl, he would have been warranted . . . in forming an opinion that his search had been successful. If, in addition to the point of general size and contour, he had found upon the arm a peculiar hairy appearance which he had observed upon the living Marie his opinion might have been justly strengthened. . . . If, the feet of Marie being small, those of the corpse were also small, the increase of probability that the body was that of Marie would not be an increase in a ratio merely arithmetical, but in one highly geometrical, or accumulative. Add to all this, shoes she had been known to wear upon the day of her disappearance, and . . . you so far augment the probability as to verge upon the certain. What of itself would be no evidence of identity, becomes through its corroborative position proof most sure. Give us, then, flowers in the hat corresponding to those worn by the missing girl, and we seek for nothing farther. If only ONE flower, we seek for nothing farther — what then if two or three, or more? Each successive one is multiple evidence — proof not ADDED to proof, but MULTIPLIED by hundreds or thousands. . . . But it is not that the corpse was found to have the garters of the missing girl, or found to have her shoes, or her bonnet, or the flowers of her bonnet, or her feet, or a peculiar mark upon the arm, or her general size and appearance — it is that the corpse had each and ALL COLLECTIVELY.*" — *Edgar Allen Poe: "The Mystery of Marie Roget."*

SUPPOSE now that we are willing to accept the fact that a finger print, in all its details, remains without change throughout life; suppose also that we understand the different types of patterns and the method of classifying them, so that a given set of prints, or even a single print, may be readily found in a collection of hundreds or even thousands; suppose that we understand and accept all this, there still remains the question *whether any two persons can have the same finger prints*, or, expressed in different words, *whether any two finger prints can be identical.*

The simplest and most sensible way to attack this problem is to examine critically a few actual finger prints, and see what they consist of, how much detail they have, how variable individually these are, and thus how much would be involved in duplicating one. Without such an examination one is inclined to continue in his first impression, that finger prints

consist of a few type patterns, that these occur in every possible combination upon the ten fingers of an individual, but that a duplication of several of these, or of the whole set, is not infrequent.

In reality a finger print is made up of a large number of independently variable details, but they are just a little too small to be made out clearly with the unaided eye. It is necessary, therefore, in order to give them the examination required, to magnify them a little, perhaps from 4–7 times. A good reading glass will magnify some 2–3 times, or, more technically, 2–3 diameters, not quite enough for careful work, but a pocket magnifier, carrying two or three separate lenses which can be combined, will give, by its various combinations, magnifications ranging from the powers of a reading glass up to 8 or 10 diameters, or more. For many purposes, especially for demonstration in court, an enlarged photograph is much more convenient than such a hand lens, and by modern methods photographs of practically any degree of magnification up to a thousand diameters can be made, and conveniently exhibited to a large audience at once by the aid of the stereopticon. The figures which follow here to illustrate the subject under consideration are in the main photographic enlargements of 4–9 diameters, a size suitable for the case, while in a previous chapter, which dealt with still smaller details, higher magnifications were used. It is important to note in this connection that a certain point is best brought out at a certain magnification, and that nothing more is gained by increasing the enlargement.

We select for our first study a pattern of the most common type, the Ulnar Loop, taken from the right middle finger of one "Bangor Billy," who was electrocuted at Sing Sing, June 12, 1911. This type of pattern occurs in the fingers of 5,000 individuals, who were counted and tabulated for the study of the frequency of patterns 31,852 times out of the 50,000 involved; with the exception of both little fingers, it is more common on the right middle finger, as here, than upon any of the other fingers (3,719 out of the 5,000). Using thus this commonest pattern, occurring on one of the fingers where it is the most frequent, 74 per cent, we are putting the matter to the severest possible test, and yet we can confidently assert that it is *overwhelmingly improbable that this pattern, in its details, exists on any other finger at the present time, or has ever been duplicated in the world's history.*

But to show the basis for such an astounding assertion, it is necessary to examine this print in greater detail, for which this photograph, enlarged four diameters, gives opportunity (Figure 126). At the natural size this print would show no especial difference from many other ulnar loops, and could doubtless be duplicated, to the satisfaction of an ordinary jury, by a dozen or more collected from the jury-box itself; yet, when seen at a magnification of some 4 diameters, as in this case, the pattern becomes

more intricate than the finest lathe-work on a bank note. It is seen that the ridges do not run in uninterrupted parallel lines, but in some places a line stops, and forms a free *end*, while the two adjacent ridges close up beyond it. In places, too, a ridge clearly branches, and forms a *fork*, and in one place in this print, but more frequently in some other cases, a small bit of ridge is seen lying, all by itself, between two long ridges. This is called technically an *island*, and occurs many times in the thumb-print shown farther on (Figure 129). A fourth kind of ridge detail, not well shown here, but possibly present in the poorly printed right lower portion, is an *interruption* or *break*, where a ridge comes to an end, but, instead of becoming discontinued, as in the case of a true *end*, continues again, leaving a short interval, or interruption, along its course.

These four sorts of details, (1) *ends*, (2) *forks*, (3) *islands*, and (4)

FIGURE 126. Print of the right middle finger of "Bangor Billy"; an Ulnar Loop with a 6-ridge count. Enlarged 4 diameters.

breaks, are, in their position and occurrence, wholly individual, and are never identical in any two prints, no matter how similar the general pattern. *Forks*, by adding to the total count of the ridges in a certain area, appear where an element of a pattern broadens out, or runs over a convex surface, and *ends*, which denote the loss of ridges, are found under the opposite circumstances, when a system of ridges contracts. *Breaks* and *islands* are seemingly accidental and without special significance, although the presence of long strings of islands interpolated between two ridges rather far apart, as are seen in Figure 129 below, may represent the ves-

tiges of a suppressed ridge, that never came to development because it was not needed.

The individual and wholly irregular arrangement of these details is well shown by covering an enlarged photograph of a print with tracing paper, and drawing upon this the details desired, without the ridges. They then appear like the one shown in Figure 127, which shows the 21 forks that occur in the left middle finger of Bangor Billy, drawn by themselves. Still another method of designating details is shown in Figure 128, where 15 forks and 20 ends are marked on the original photograph, the former designated by numbers, the latter by letters. The difference

FIGURE 127. The forks of the preceding figure, shown by themselves. There are 21 of these, counting the separate forks of the compound pieces. The apparent breaks at *a* and *b* are due to lower places in the ridges, such as are likely to occur where two ridges meet.

in count in the forks shown in this and the previous figure is due to the fact that the area included was not quite the same in the two. Also, in Figure 128, in the small area enclosed by a line, where the ridges have become indistinct through some former injury, involving suppuration, the forks and ends are not used.

Thus the analysis of this common type of finger print, *using only the details that are obvious to any one in a 4 times magnification*, has resulted in finding, aside from the pattern and the number of ridges between delta and core, some 15 forks, 20 ends, and an island, *the location of each of which*

is an individual character, less easily duplicated than a Bertillon Measurement. In experiments made by the authors, where the forks alone of similar ulnar patterns were drawn by themselves on tracing paper, as in Figure 102, and then placed two and two against a window pane, if they were so held that a single fork on one coincided with one on the other, it rarely happened that there was another coincidence, even approximate, in the entire print. Otherwise, and in general, they were all at complete variance.

Summarizing the results of our examination of this single pattern, we find that even a low magnification brings out a large number of ridge

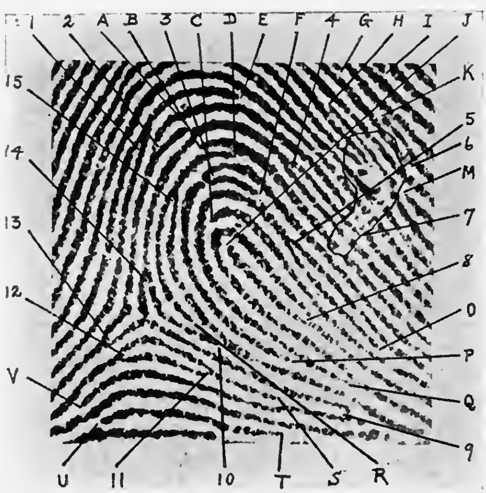


FIGURE 128. The same print as Figure 126, with both forks and ends designated, the former by figures, the latter by capital letters. The enlargement is the same as in Figure 126, but the area shown is a little less, which reduces slightly the number of details shown.

details, quite unnoticed by one who makes a casual inspection with the unaided eye. We find that, far from considering all ulnar loops the same, or even similar, they differ individually by numerous highly variable characters, and that, in order for a second pattern to duplicate this, it must have, in addition to the ulnar loop type, and a ridge count of six, some 15 separate forks, 20 ends, and one island, included within the middle part of the entire print, and, a condition most impossible to meet, each and every one of these 36 details must be placed on exactly the corresponding ridge, and at the same place in the ridge.

Even though two ulnar loop patterns, each with a ridge count of 6, should be found with a coincidence in one of 36 separate details, it would be very hard to find one in which a second point also coincided, and if a second, it would be progressively much harder to find one with a third, a fourth, and so on.

The principle is the same as the one used by Edgar Allen Poe in the identification of the body of Marie Roget, given at the head of the chapter, where each added detail corresponding to the missing girl made the case stronger in geometrical series; "proof not added to proof, but *multiplied* by hundreds or thousands." Thus, in finger prints, if a fork in one corresponds to an identical one in another, it suggests at once that the two are from the same finger; if a second coincides, the proof is strengthened many fold; if three are coincident, the proof "verges upon the certain," and so on. The number of these proofs following proofs requisite to convince a man may differ somewhat individually, but in any case a coincidence of eight or ten points ought to be sufficient to convince anyone. In the Marie Roget case there was about this number of different characters, and these would pass in any court in the land as absolute proof; why not in a case dealing with the same number of forks and ends in a finger print? Naturally, to a man who knows little or nothing about the subject, the presence, for example, of a fork on the third ridge from the delta of an ulnar loop, running toward the core, and seven sweat pores up from the straight line joining core and delta, would not appeal as nearly so strong a proof of identity as the size of the shoes, yet the former is actually more difficult to duplicate than the latter; again, an end on the fourth ridge, a little above the other, is an added proof comparable to a flower on the bonnet, and the fact that the two are found together in the one case is just as truly "multiple evidence, proof most sure" as in the other. But Poe was content to show coincidence in not more than nine or ten details, while even the simplest and least complex finger print presents some thirty to fifty, or more, each one of which is more individual and harder to duplicate than any of the larger characters found upon a body.

Practically every writer on the subject has made a set of calculations of the percentage of chance involved in duplicating a finger print, and as the line of mathematical reasoning is simple, and brings out still stronger the practical impossibility of duplication, it may prove of interest to the reader to take it up anew in these pages.

As a simpler case, and one that deals with ordinary things, with which all are familiar, we shall consider first the identification of the corpse in our initial quotation. Marie Roget's body was positively identified through coincidence in the following particulars:

1. Size.
2. General appearance.

3. A peculiar hairy appearance on the arm.
4. Small feet.
5. Shoes like those worn on day of disappearance.
6. Garters like those worn by Marie.

7–9. Three or more flowers in the bonnet, each like one known to have been worn by her.

This series of coincidences was considered sufficient proof of identity, and, laying aside all idea of an intentional substitution, of course, it would be considered by practically every one as sufficient. Stress must be put upon the factor of "multiple evidence," each new proof making the total proof many times stronger than before.

Let us now put this case to the mathematical test, and calculate the chances against such a body, with the characters noted, being the one sought.

Beginning with the first item, that of size, in the entire absence of the Bertillon measurements, or any other accurate system, this item of small stature is not of great value. Perhaps one girl in four may have suited the conditions; that is, the chance of duplicating the body in this one particular may be said to be *one in four*.

The second quality, also intangible, and difficult to put down in either words or figures, rests upon the testimony of those who knew her by sight, but, as the body was in poor condition, it would be well within the truth to set down this chance as *one in six*, meaning that in every six such bodies, five would be instantly rejected, while the sixth would be a possible candidate.

Taking, now, these two characters, and considering it the task of the court to select the right one out of a large number of bodies in similar condition. Selected by the first character alone, one body in four would be selected, but the second character, which would select one body in six, would not begin over again and make the selection from the original lot, but from the one fourth already selected from the original lot; that is, one sixth of one fourth, or one twenty-fourth. In other words, one body in every twenty-four would correspond to the missing Marie in the two first characters.

The third character is a very definite one, and, if carefully described, might not occur in one body out of several hundred. Here, however, as no accurate description of this character exists, there is a much greater chance of the occurrence of some such appearance, calculated to satisfy a man who had seen the mark, but had not observed it accurately. We will call the chance *one in ten*. But this means, after the selection has been made on the basis of two other characters, not one out of every ten young female corpses, but one out of the one twenty-fourth already selected, which would mean $\frac{1}{4} \times \frac{1}{6} \times \frac{1}{10}$ or $\frac{1}{240}$. That is, a body correspond-

ing in the first three characteristics only of those given, would be found only once in 240 times, or the chance of the body being, not Marie Roget, but some one else, as judged by the presence of three characteristics, would be 239 out of 240, a fairly safe chance to take.

But we have still left some six more characters, each one of which is to increase, to a constantly greater amount, the amount of chance. The fourth character, not an uncommon one for a young girl, might be considered as occurring in one out of three; the fifth, once in eight times, the sixth, once in five, and the seventh, eighth, and ninth, each flower being a separate character, once in ten times for each flower. Multiplying these figures, expressed as fractions, into the previous ones, we have

$$\frac{1}{4} \times \frac{1}{6} \times \frac{1}{10} \times \frac{1}{3} \times \frac{1}{8} \times \frac{1}{5} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10}$$

which yields the prodigious total of $\frac{1}{28,800,000}$ This means that, by the doctrine of chances, *only one girl's corpse in twenty-eight million, eight hundred thousand could have all nine characteristics.* These nine characters, then, no one of which is in itself at all uncommon, when taken together, would serve to designate one person out of nearly thirty millions. It is also to be noted that each added character increases the total vastly more than do any of the previous ones. Just one more character added to the nine, and found once in every ten girls, would increase the twenty-eight millions to two hundred and eighty millions, and so on. An eleventh character, also found once in ten girls, would select and distinguish this body from all the inhabitants of the globe, and more, for it would increase the chance of a coincidence to one in more than two billions.

We have thus obtained the formula for calculating the chance of occurrence of any number of details: *we first estimate the chance of occurrence of each detail separately; we put it in the form of a fraction, and we multiply all the fractions together. The result will give the chance of occurrence.*

The reason for this rule of chance may be readily worked out by the following method. Suppose we have in a cup the four letters *a, b, c, d*, either just the four, or an equal number of each, as 25 *a*'s, 25 *b*'s, 25 *c*'s, and 25 *d*'s; and suppose we wish to draw a *c*. If the letters are well mixed there is one chance in four, or $\frac{1}{4}$ of a chance. Now let us take another cup, with six letters equally represented, *e, f, g, h, i, j*, and wish to draw an *h;* we have here one chance in six, or $\frac{1}{6}$ of a chance.

But now let us suppose that we wish to draw the two letters *ch*, one from each bowl, and get both at the same time; it is now only once in four times that we can get a *c*, and then, having obtained this, only once in six times that we also get an *h*. That is, the chance of getting from the two bowls *c* and *h* in succession is 4 x 6, or 24. If this is not clear, we shall find that the possible combinations of letters to be taken from the two

bowls are: *ae, af, ag, ah, ai, aj; be, bf, bg, bh, bi, bj; ce, cf, cg, ch, ci, cj; de, df, dg, dh, di, dj;* twenty-four in all, and with an equal chance of getting any one of them. If there were a third bowl, with ten more letters in it, *k, l, m*, etc., and suppose that, after succeeding in drawing from the others at the same trial the desired *c* and *h*, we were expected to draw a *q* from this third bowl, the chance would be naturally but one in ten. But, as we can hope to get the *c* and the *h*, so that we are ready to try our luck at the third bowl but once in twenty-four times, and if then we have but one chance in ten of getting the *q*, the actual chance of drawing in succession the *c* from the first bowl, the *h* from the second, and the *q* from the third is once in 24 x 10 times, or 240. In other words, taking one letter from each of the three bowls in succession there are just 240 combinations, which are made by taking each of the previous 24 combinations in connection with each one of the ten in the third bowl.

If a fourth bowl had only three letters, with $\frac{1}{3}$ of a chance of drawing one of them; when added to the rest it would, even with its small number of letters, make the problem three times as difficult, as it would increase the number of combinations threefold, and make the chance one in 720.

This problem of the letters in bowls is, however, only another form of that of the identification of Marie Roget; the letters in each set standing for the other characters. For the first, the small size, it was supposed that this occurred but once in four times; that is, that it represented the *c* of the first bowl, and so on. The characteristics actually known to have been present in the girl sought are represented by the successive letters desired, *chq*, etc., which, taken in combination, make the likelihood that the body could be any one else than the one known to have these characteristics as remote as the possible chances against drawing all these letters in succession from a series of nine bowls.

To come now to the actual case, that of the identity of a finger print, each one of the definite details is as individual as were the nine characters upon which the identification of Marie Roget was based. Probably they are much more so, as many of the latter, like the size, were rather vague. They are of course minute, but this is no reason why they should not be of as much value in identification as larger and more obvious characters. Any nine details selected from the right middle finger of Bangor Billy would be equal in identification value to any of those used in identifying Marie, and the chance of finding the same nine in any other print would be probably much less than that of finding a second body with identical points.

There is, however, in all of these problems involving chance, an important factor which, in our present lack of precise knowledge, we have to assume; and that is, the exact, or even approximate, percentage of occurrence of the different details, i.e., the number of different letters to put into

each bowl. In the Marie Roget problem we did not know by statistics how large a percentage of girls were small, like the corpse; we only *assumed* that it was one in four. We find in the finger print in question a fork, opening downward, and formed by the second and third ridges, counting from the delta (15 in Figure 128). We have no definite data for knowing the percentage of occurrence of this detail in ulnar loops with a count of six ridges, but the variability of the ridges and their details in general is so great that we may be warranted in asserting that it is small. As this point cannot now be determined, it seems fair to give it a percentage of occurrence much in excess of what can be possibly the case, and assume that it occurs in this type of pattern once in four times, or $\frac{1}{4}$; that is, our first bowl has four letters in it.

For the second detail we may take the end designated as *C* in Figure 128, and may assume that this, too, occurs in such patterns once in four times. We may then select seven other conspicuous details, and give to each the same percentage of occurrence. The chance of duplicating all of them in a single print is, according to our rule, 4 x 4 x 4 x 4 and so on to 9, that is, 4^9, or 262,144. With the chance of occurrence as assumed, which is very much too great, we may expect a duplication of all nine of these details once in about 250,000 times in ulnar loops with a ridge count of 6; but this count of 6 is itself not very common, and would scarcely occur oftener than once in 25 prints. Therefore, to find these nine details duplicated in the right sort of print, one would have to look over, not the 250,000 odd prints first computed, but this sum multiplied by 25, or 6,553,600.

As a matter of fact it is absurd to use anywhere near as small a ratio as 4 to 1, for the percentage of occurrence of any one of these details; it would be rather 1 in 50, or 1 in 100, in either of which cases the final result, although using only nine details as before, would pass the power of the human mind to conceive. Thus, using 50 instead of 4, the chance of duplicating these nine details would be one to the ninth power of 50, which equals 1,953,125,000,000,000, one quadrillion, nine hundred and fifty-three trillion, one hundred and twenty-five billion, a sum more than one million times the number of human inhabitants of the entire earth.

If such inconceivably great numbers result from calculating the chances involved in the duplication of only nine ridge details, what would be the results if the chances were calculated of duplicating all of the details that actually occur? In the central part of the finger print under consideration, we have shown (Figure 128) 15 forks and 20 ends, in all 35 separate details. At the low estimate that each of these might be found once in four times, far below the actual truth, the chances against their recurrence in the same combination in a second print would be the 35th power of 4; 1,180,591,620,737,891,303,424; more than one sextillion. When

even a single new detail is added to this, — that is, when the 35th power is raised to the 36th, — this number is greatly increased, yet 36 or 37 details is a very small number to find in an ordinary print. With 36 details we get nearly five sextillions of combinations, — that is, of chances, — and by adding 4 more features, making 40 in all, we get more than a septillion. If an entire print be counted and not merely the middle portion, there are found from 60 to 100 separate details; and with 60, still with but one chance in four for the duplication of a single detail, the total chance is but one in the number 1,329,227,999,290,590,813,080,818,239,800,344,576, that is, more than one undecillion. With 100 separate details the chance of duplication is one in a number composed of 61 separate digits.

As practically any number of details from perhaps thirty to a hundred might be used as the basis of such a calculation, and since also the chance for the occurrence of a single feature may be assumed at anything between four, the number usually taken, and fifty or even a hundred, it is to be expected that the different investigators who have busied themselves with similar calculations should arrive at widely different results Nor is this any disparagement of the method or the results, since all agree in the statement that the chance of duplicating a finger print are practically incalculable. Galton, whose figures are much the lowest of all, gives the chance of duplication as one in sixty-four billions,* and if any one finds this number too small upon which to base a conviction, let him multiply this number by itself, and he will get the chance of the duplication of two fingers. Still, as it is, the 64,000,000,000 possible patterns of Galton's estimate are more than four times as many as there are fingers in the world, counting the number of human inhabitants as 1,400,000,000, the latest estimate. This number, confessedly a low one, would thus supply, without repeating, four and one-half worlds like ours, each with 1,400,000,000 inhabitants.

For example, both Balthazard and Seymour base their estimates upon 100 details, each with a possibility of recurring once in four times. The former uses all the figures, as calculated (the 100th power of 4), while the latter uses ciphers to mark the places following the first digit. Their results are thus as follows:

Balthazard: 1,606,937,974,174,171,729,761,809,705,564,167,968,221,-676,069,604,401,795,301,376.

Seymour: 1,000,000,000,000,000,000,000,000,000,000,000,000,000,-000,000,000,000,000,000,000.

Something of the possibilities of variation in a finger print may be shown by a glance at the following five illustrations, which show some of

*Galton used the English method of notation, and wrote "sixty-four thousand millions."—*Finger Prints*, p. 110.

the details of certain complicated forms,—which show well their individual variation when compared with Figure 126 and with each other. Figure 129 is a typical *twin loop*, with numerous islands, in rows between the ridges, suggesting that these minute parts are the vestiges of ridges, lost or suppressed during early development; and Figure 130 shows the 35

FIGURE 129. A typical Twin-Loop, magnified 2 diameters. Note the numerous "suppressed ridges," alternating with the well-developed ones. So far as has been observed (from the second year of life on to middle age) these are as constant as the normal ones, and never become full ridges or disappear.

FIGURE 130. The 35 separate forks of the previous figure, isolated from the rest, and shown at the same enlargement.

forks of this print, drawn by themselves. In the same way Figure 131 is a *lateral pocket*, another variety of a whorl, having no less than 50 forks and 60 ends, which are shown by themselves in the two next figures (Figures 132 and 133). The large system of forks that appears at the head of

the loop is a rare peculiarity that has never previously been brought to the attention of the authors, and forms a striking characteristic of this particular finger.

A convenient method of bringing out and counting the forks and ends in a given finger print, devised by Mr. Albert S. Osborn, the handwriting expert, is shown in the next figure (Figure 134). An enlarged photograph of the print is covered with one hundred small squares, ten on a side, and the details in each square counted separately. The results should be set down in the corresponding squares of a sheet of paper, representing a fork by an *f* and an end by an *e*, one letter for each separate detail. Naturally, as the area of separate prints of the same finger varies in accordance with

Figure 131. A typical Lateral Pocket Loop, magnified 2 diameters.

the amount of pressure, slight rolling, and other conditions when the print is taken, the actual number of details is of but little value, but the location of these details, especially through the region of the pattern proper, is often extremely convenient. It will be noticed, as indicative of the structure of a pattern, that the number of details is especially large in the squares which include the turns of the loop, and the disturbance caused by the delta; that is, in those regions where there is the greatest amount of disturbance in the course of the ridges. The original photograph used here gave a magnification of 9 diameters, a convenient size for this work. The illustration here given is reduced.

The forks and ends alone, isolated from the rest, are shown by themselves in Figure 135, which furnishes in itself a sufficient argument against the proposition that a single finger print can be duplicated. A finger print is too complex a structure and its numerous details, definite as they

are, are as arbitrary in their occurrence and arrangement as are the pebbles on the beach, no square foot of which could ever be duplicated by any other. It is always so with natural objects; the details are so numberless, and so independent of the rest, that there are no duplicates. No two heads of clover, no two ears of corn, can be exactly alike; an instantaneous photograph of ocean waves can never be duplicated, save by a second print from the same negative. It is claimed that, in the manufacture of chemical salts the same conditions cannot be exactly reproduced in two separate operations, and that consequently the results will differ in such details as the form and size of the crystals. So marked are these differ-

Figure 132 The 50 separate forks of Figure 131, isolated from the rest, and shown at the same enlargement. The large complex of forks at the head of the loop, which adds so materially to the total count, and forms so distinctive a character in the print, is a striking peculiarity that has never been brought to the attention of the authors. It is not the result of a scar.

Figure 133. The 60 ends of Figure 131, isolated from the rest. These, and the forks in Figure 132, 110 details in all, are to be found in this one print, shown as a whole in Figure 131. In order to duplicate this, each one of the 110 must occur in its proper relation to the rest, and with the same relation to each ridge. In addition to all this, the duplication must include the numerous islands, which are not considered here.

ences, as seen under the microscope, that in a criminal case involving arsenic, for example, an expert can often match a sample with a lot obtained from a particular druggist, and thus prove the source of supply beyond doubt.

Again, when two natural objects are actual duplicates as far as the eye can detect, all trace of even a remote similarity will vanish if the objects be sufficiently magnified. It is conceivable that two maple leaves might be found of exactly the same size and shape, with the margins everywhere coincident, and with the ribs showing the same number and

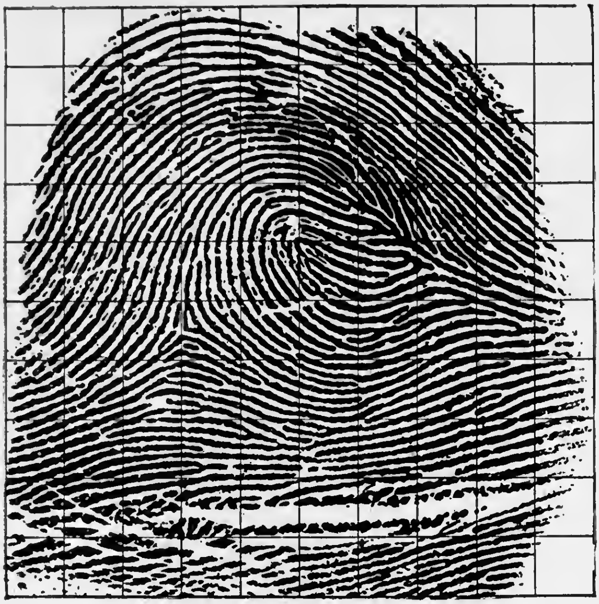


FIGURE 134. Right thumb of a little girl (R. E. P.), divided into 100 squares, according to the method of A. S. Osborn, for convenience in counting the details. These are shown isolated in the next figure, and are enumerated in corresponding squares in the Table that accompanies the text. The work was originally done on an enlarged photograph and is presented here reduced to 3 diameters.

		f	o	e						3 1
	f e	ee	ff e	f e	f ee	o	ee	ee		5 11
f e	e	f ee	f e	e	eeee	eeee	ee	ee	o	3 18
eee	f	f ee	eee	ff ee	eee	fffff eee	fff ee	o		12 18
		ff	ee	ff e	fffff	ff e	f ee	f ee		13 12
ee	o	f e	ff eee	eee	eee	f ee	ee	f e	eee	5 20
e	ee	f eeeeee	f e	e	e	e	e	eee	e	3 18
o	ee	o	f eee	ff e	f eeee	e	ee	o		4 13
f	e	e	ee	e	o	o	o	o		1 5
e	e	ee	e	e	e	eeeee	f	ee		1 14

50 forks; 130 ends.

Table to Accompany Figure 134, Indicating the Features Occurring in the 100 Squares. f = fork; e = end.

arrangement, yet, if a single interspace between corresponding ribs was magnified enough to show the finer network, all similarity would vanish at once. In butterflies of a species having a complicated marking on their wings it is a difficult matter to find two that, even to the unaided eye, exactly correspond, and even in such a case the separate scales which form a given spot would be found to differ in number in the two, and this could be seen with a magnifying power not exceeding 10 or 15 diameters. Even two hairs, each but a half-inch in length, would be found absolutely unlike if magnified sufficiently to show the epidermic markings that cover the surface with a fine tracery.

This last is confessedly an extreme case, and would require a magni-

FIGURE 135. The isolated forks and ends of the previous figure; 50 forks and 130 ends. Note several fork complexes, any one of which would be sufficiently characteristic of the pattern to identify it. The print shows also numerous characteristic islands.

fication of probably 600 diameters to show it, but these are not high powers for a professional microscopist, and with the proper apparatus such an object can be photographed at the magnification indicated, so that the results could be readily shown to any one who cared to examine.

It is the individuality of the brain, the eye, the muscles and bones of the arm, which come to visible expression in the individual handwriting,

and this individuality is so great that no two men write alike. The skilled flourishes of the expert forger, although they may deceive the unaided eye, when magnified but a few diameters betray by their uncertain course that they are but clumsy copies, made by another and a different human mechanism.

Thus it is not surprising that the print of every human finger, or of every patch of palm or sole, with its numerous forks, ends, breaks, and islands, is more individual than the most complicated signature, and involves many more individual details.

Finally, there is never the slightest doubt of the impossibility of the duplication of a finger print, or even of the small part of one, on the part of any one who has carefully studied the subject at first hand, whether finger-print expert or anatomist; the only doubters are those who have

FIGURE 136. Print of the right middle finger of J. C., magnified 2 diameters. The area enclosed in the square is shown in Figure 138, at an enlargement of 11 diameters. The line used in taking the ridge count is given, and shows a count of 18.

never taken the trouble to look for themselves, and who argue from the basis of their own prejudices and preconceived opinions. These critics are fond of asserting that, even granting that there are minute differences in similar finger prints, which can be detected by experts, yet, for all practical purposes these differences are insufficient; that, in short, these differences are too slight for the "ordinary man" to understand. To meet this objection the authors have been at some pains to look over a large collection of finger prints, selecting from them two which are the nearest

alike that could be found. These are also examples of the commonest, and simplest type, the Ulnar Loop, where there is less range of variation than in any of the rest. They are both taken from right middle fingers where, with the exception of the little fingers, this type occurs with the greatest frequency (3,719 out of 5,000). The separation of these two prints, then, intentionally presents the most difficult case possible for the

FIGURE 137. Print of the right middle finger of J. W., magnified 2 diameters. This was selected from several hundred prints of right middle fingers, in an endeavor to get the nearest match to Fig. 136. Compare also another very similar one in this chapter (Figure 126); also the details of the patterns of Figures 126 and 136, shown in Figures 116 and 117 of the previous chapter. The area enclosed in the square is shown in Figure 139 at an enlargement of 11 diameters. The line used in taking the ridge count is also given, and shows a count of 15.

"ordinary" or "practical" man specified by our critic, and yet it is for him (and the critic) that this analysis is especially written.

At the natural size, just as they were taken, it must be acknowledged that these two prints do look very much alike, but shown at the slight magnification of 4 diameters (Figures 136 and 137), a few of the most striking differences may be perceived. Of these the most important technically is the difference in ridge count, previously explained; that is,

the number of ridges in each crossed by a line drawn straight from the point of the delta to the point of the core. This line has been drawn in both figures, and we think that even the ordinary man would experience little difficulty in counting 18 in the print of J. C., and 15 in that of J. W.

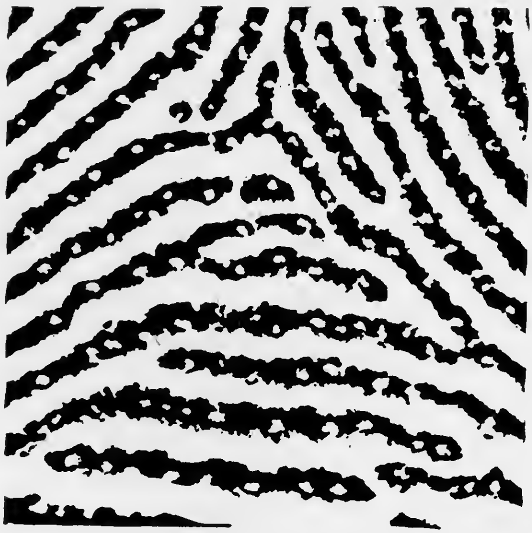


FIGURE 138 The square area marked in Figure 136, enlarged to 11 diameters.

FIGURE 139. The square area marked in Figure 137, enlarged to 11 diameters.

Coming now to the details, the authors call the attention, not to the entire area of the prints, but to simply a very limited portion of it,— the part bounded by the square, which includes the delta in each case. Although the prints were selected for general similarity, especial pains were taken to select also prints with similar deltas, and here, at the 2 diameter enlargement, there is in fact little difference to be seen. By a sufficiently larger magnification, however, even here the similarity largely vanishes, and the ridges are seen not to correspond in the slightest degree (Figures 138 and 139). Even the deltas, which at 2 diameters seemed so similar, are distinctly unlike, for in the print taken from the individual J. C. (Figure 138,) both of the two lower legs extend entirely across the square, while in that of J. W. (Figure 139,) the one on the right is very short. Below the delta in the first there are three ends in succession, directed toward the right, while in the second there is one end directed toward the left; then a continuous ridge; then a second end to the left; then one to the right, and then a second continuous one. Thus, with an enlargement of only 16.5 diameters, that of a good pocket magnifier, there is in this region no similarity other than the general form and position of the delta; in a region, that is, where at the natural size, or at an enlargement of only 4 diameters, the similarity seemed so great as to cause confusion.

These two prints, shown in Figures 136 and 137, show also the marked difference in the fineness of the ridges, which in itself constitutes a striking character, aiding the eye not a little in the selection of a given print from a file. The actual enlargement of the two is the same, but the finer ridges of J. W., a peculiarity noted in all the prints of this man, give one the impression that this print is not so much enlarged as the other one. Another thing brought out by the two prints, and especially by the enlarged details (Figures 138 and 139), is the difference in printing, which, through variation in the amount of pressure, the amount of ink, and so on, gives very different results. Of the two, Figure 138 is the better print, and shows the sweat pores so well that they could be severally counted; in Figure 139 on the other hand, although several sweat pores are indicated, mainly by notches, they cannot in general be well made out.

CHAPTER X

HISTORY OF THE SUBJECT OF IDENTIFICATION BY FRICTION RIDGES

"*Twenty years have elapsed since the discovery of 'Finger prints' by Francis Galton. The average man does not realize that this mode of identification is absolutely unassailable, never having failed when fairly tried. Like ridges have never been found on the fingers of any two persons. To-day it is utilized in many odd but useful ways. Unlettered persons no longer need to sign documents with the mark of the cross; a finger print is far more positive and absolutely proof against forgery. Banks are already confirming signatures and corporations are beginning to identify employees in this way. Finger prints are taken as signatures to receipts for payment to the workmen constructing the Panama Canal.*

"*Lieutenant Faurot, of the New York Police Department, has suggested also that 'birth certificates be accompanied by the baby's and mother's finger prints, and it has been mooted even that all individuals establish a record of their identity by depositing their finger prints in the police or some other legally designated office, to be duplicated at a central office at the national capitol. Since the finger prints are reliable until decomposition has obliterated them, their value in establishing lost identity is obvious. Many suits for fraudulent insurance claims would be prevented if the insured were compelled to add a finger print to the usual signature, furnishing mute but unerring evidence." — From "The New Reference Atlas of the World," published by C. S. Hammond and Co., New York, 1915, p. 176.*

GALILEO, Copernicus, Newton; Stevenson, Fulton, Morse; the world is justly proud of her roll of great men who have brought forth great inventions, and revealed great natural laws. Yet no one of them all has done his work alone. Each achievement is due to the labor of many generations of men, and when the world is brought up to the point of expectancy, one individual takes the final step, and his name becomes immortal on the lips of men.

Who first noticed that the palmar surface of the hand and fingers was covered with ridges as well as wrinkles, or that the ridges formed themselves in places into definite patterns, no one may say. This observation has, without doubt, been made by countless individuals of early times in an idle moment. The earliest record of such a discovery is probably that carved in Indian picture writing upon the smooth face of a cliff in Nova Scotia, where the outline of a hand, probably traced around in

schoolboy fashion, is covered over with two sorts of lines, regular and parallel ones to represent the ridges, and irregular and scrawly ones to represent the wrinkles. Upon the ball of the thumb is a conspicuous spiral, and upon three of the other fingers are suggestions of other patterns (Figure 140).* As this scratched picture is very old, at least older than the first visit of Europeans to the region, it stands at present as the oldest

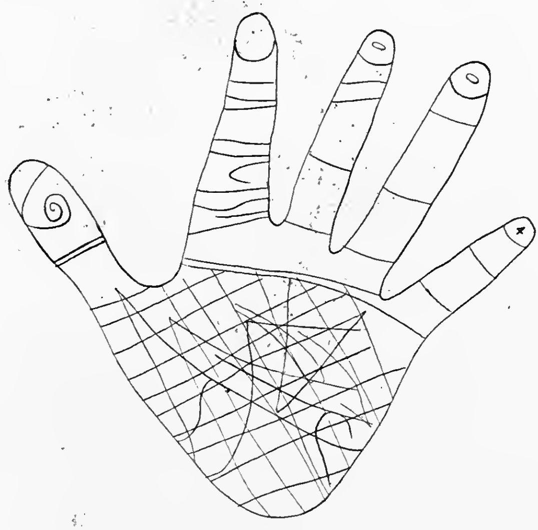


Figure 140. An aboriginal Indian pictograph carved upon the smooth surface of a slaty rock on the edge of Kejemkoojic Lake, Nova Scotia. Notice the representations of the finger patterns. Upon the palm there are two sets of lines; the parallel series crudely represent the friction ridges, the wholly irregular ones the wrinkles. One-half the size of the original drawing. From author's article in *Popular Science Monthly*, 1903. After Mallory.

recorded observation of the finger prints, although something still older may at any time be discovered.

The first definite mention of the patterns on the balls of the fingers was made in 1686 by Marcello Malpighi, Professor of Anatomy of the University of Bologna, who spent an active life in investigating all parts of the human body by means of that recently discovered instrument, the microscope, and thus founded the science of histology. The visitor to Bologna is still shown the rooms where he worked and the lecture hall where he first expounded to his students the details of the human kidney,

* Col. Garrick Mallory, in Tenth Annual Report, Bureau of Ethnology, Washington, 1888–89, p. 740, Figure 1255.

the complicated tubular structure of which he had discovered by means of his new lenses. His successor, Galvani, discovered, also in the same room, that form of electricity which long bore his name, galvanism, and

FIGURE 141. Marcello Malpighi (1628–1694). Portrait by Tabor, and presented by Malpighi to the Royal Society of London, where it now is. (From Locy: Biology and its Makers, by permission of the author.)

in the little square in front he now stands, carved in stone, delivering a lecture to the passer-by, wildly gesticulating, as was his wont, with arms stretched far apart, and with head and body bent over to his imaginary students.

And it was doubtless in this spot, under the shadow of the cathedral

of San Petronio, whose archbishop has become the latest pope, Benedict XV, that Malpighi turned his attention to the examination of the hand. He found the palmar surface covered with "certain elevated ridges" which "describe divers figures," and at the ends of the fingers become "drawn into spirals." Through the middle of the ridges, when examined with the microscope, he perceived "the open mouths of sweat glands." This was all he wrote at that time, yet the figures formed by the ridges on

FIGURE 142. Marcello Malpighi (1628–1694). Portrait taken from the Life of Malpighi by Atti. (From Locy: Biology and its Makers, with the author's permission.)

the finger balls seem to have made an impression upon him, for a year later in a letter to a friend he again refers to them. "I look at the end of a finger," he writes, "and perceive these ridges to be drawn out into loops or spirals."

But in Malpighi's time a whole new world had just been opened up by means of the newly discovered tool, the microscope, and amid the wealth of things now seen for the first time, nobody could stop long upon any one object, especially so small and simple a thing as a finger tip, and these facts seen by the Italian anatomist soon became forgotten. Not until 1823, some hundred and thirty odd years after Malpighi had seen

the *diversas figuras* of the finger balls, was there any known mention of these structures. At this date there was published at Breslau a treatise on the skin and the eye, the work of Dr. J. E. Purkinje, Professor of Anatomy in the university there. The treatise is in the form of a small octavo of fifty-eight pages, and "written in a form of Latin that is difficult to translate accurately into free English." *

The work is now extremely rare. Galton could not find a single copy in England, either in public or private libraries, but succeeded after

FIGURE 143. John Evangelist Purkinje (1787–1869). (From Locy: Biology and its Makers, with the author's permission.)

some search in securing one from the continent through the librarian of the Royal College of Surgeons of London. This copy is still there. A search by one of the authors in this country, and an advertisement in scientific journals, located also a single copy, that in the Surgeon-General's office in Washington. There are undoubtedly several more copies in the universities of continental Europe.

Its title is a long and formal one, stating that it was presented by John Evangelist Purkinje in his public examination for the degree of Doctor of Medicine, Dec. 22, 1823, and that its subject is "*Commentatio de Examine physiologico Organi Visus et Systematis Cutanei*"; that is, a

* Galton, "Finger Prints," 1892, p. 84.

commentary of the physiological examination of the organ of vision and the cutaneous system. In a small part of this little pamphlet he speaks of "the wonderful arrangement and curving of the minute furrows connected with the organ of touch on the inner surfaces of the hand and foot, *especially on the last phalanx of each finger*" (our italics).

Of the course of the furrows here he made "numberless observations" and finally classified them in nine groups, as follows:

1. *Flexuræ transversæ* (transverse curves).
2. *Stria centralis longitudinalis* (central longitudinal stripe).
3. *Stria obliqua* (oblique stripe).
4. *Sinus obliquus* (oblique loop).
5. *Amygdalus* (almond).
6. *Spirula* (spiral).
7. *Ellipsis* (ellipse).
8. *Circulus* (circle).
9. *Vortex duplicatus* (double whorl).

From the figures which accompany the text it is clearly evident that his Types 1 and 2 are arches, 1 being a flattened arch and 2 a tented arch; that 3 and 4 are loops, with a difference in the shape of the core; that 5, 6, 7, and 8 are whorls, and that 9, his "double whorl," is a twin-loop. (See Chapter V.)

This paper, remarkable as it was, and noteworthy as being the first that made any attempt to classify the patterns of the finger balls, was, as its title runs, "physiological" only, and there was no suggestion of the application of these variations in the pattern to the problem of identification. As in all great inventions and discoveries the honor of first proposing this must be shared by at least two men, while others have co-operated by furnishing many facts and suggestions, necessary for the practical working of the system. These two men were both Englishmen; they were both living in Asia at the time of their discovery, and they both announced their ideas through the columns of an English scientific journal, entitled *Nature*, within a month of each other, in the year 1880. In the issue of October 28 of that year, Dr. Henry Faulds, of Tsukiji Hospital, Tokio, published a letter with the title "On the Skin Furrows of the Hand," in which he unfolded the method of taking finger impressions with printer's ink, and at the same time sent a number of samples to the editor.

He was led to this field of inquiry by finding finger marks on some prehistoric Japanese pottery, which he compared with the fingers of living people. To his amazement he found in the latter the same complex maze of fine ridges that came out so clearly upon the surface of the pottery. He says, "Where the loops occur the innermost lines may simply break

off and end abruptly; they may end in self-returning loops, or, again, they may go on without breaks after turning round upon themselves. Some lines also join or branch like junctions in a railway map."

Like all later investigators, he employed prints, instead of the real fingers, in his studies, and devised for this a method strikingly like that of the present time. After describing this he discusses the various directions of study to which this new line of work may lead, anticipating here practically every line which has been developed since then, such as heredity, ethnology, comparisons with other mammals, etc. He suggests in considerable detail the possibility of tracing a criminal by a chance impression, but evidently does not think of the possibility of classifying the impressions or of using them for the broader purposes of general identification. The letter is so remarkable that we give here the greater part of its contents, beginning with his rules for taking the "nature prints."

"A common slate or smooth board of any kind, or a sheet of tin, spread over very thinly and evenly with printer's ink, is all that is required. The parts of which impressions are desired are pressed down steadily and softly, and then are transferred to slightly damp paper. I have succeeded in making very delicate impressions on glass. They are somewhat faint indeed, but would be useful for demonstrations, as details are very well shown, even down to the minute pores. By using different colours of ink, useful comparisons could be made of two patterns by superposition. These might be shown by magic lantern. I have had prepared a number of outline hands with blank forms for entering such particulars of each case as may be wanted, and attach a specimen of hair for microscopic examination. Each finger-tip may best be done singly, and people are uncommonly willing to submit to the process. A little *hot* water and soap remove the ink. Benzine is still more effective. The dominancy of heredity through these infinite varieties is sometimes very striking. I have found unique patterns in a parent repeated with marvelous accuracy in his child. Negative results, however, might prove nothing in regard to parentage, a caution which it is important to make.

"I am sanguine that the careful study of these patterns may be useful in several ways:

"I. We may perhaps be able to extend to other animals the analogies found by me to exist in the monkeys.

"II. These analogies may admit of further analysis, and may assist, when better understood, in ethnological classification.

"III. If so, those which are found in ancient pottery may become of immense historical importance.

"IV. The fingers of mummies, by special preparation, may yield results for comparison. I am very doubtful of this, however.

"V. When bloody finger marks, or impressions on clay, glass, etc.,

exist, they may lead to the scientific identification of criminals. Already I have had experience in two cases, and found useful evidence from these marks. In one case greasy finger marks revealed who had been drinking some rectified spirits. The pattern was unique, and fortunately I had previously obtained a copy of it. They agreed with microscopic fidelity. In another case sooty finger marks of a person climbing a white wall were of great use as negative evidence. Other cases might occur in medico-legal investigations, as when the hands only of some mutilated victim were found. If previously known they would be much more precise in value than the standard *mole* of the penny novelists. If unknown previously, heredity might enable an expert to determine the relatives with considerable probability in many cases, and with absolute precision in some. Such a case as that of the Claimant even might not be beyond the range of this principle. There might be a recognized Tichborne type, and there might be an Orton type, to one or other of which experts might relate the case. Absolute identity would prove descent in some circumstances."

At the end of the letter Faulds adds, "There can be no doubt as to the advantage of having, besides their photographs, a nature-copy of the forever unchangeable finger-furrows of important criminals."

Aside from several suggestions which have not been substantiated by later investigation, this author has anticipated in a remarkable manner the most important lines of the subject, even to the identifications of a man by the traces of finger patterns left upon the objects he has handled, and the identification of a detached hand.

Viewed by itself, as the first *published* suggestion of the use of finger prints for personal identification, Dr. Faulds might have a legal claim to the discovery of the system. As a matter of fact, however, while Faulds first noticed the impressions in 1877, another Englishman began to actually use finger prints for identifying individuals in 1858 or thereabouts, and was still continuing the practice at the time of Faulds' letter. This was Sir William J. Herschel, who was "Collector" (*i. e.*, chief administrator) of the Hooghly district of Bengal, India, for some thirty years or more. His first attempts concerned two contracts with natives, written in the Bengali language, upon which he had caused the signers to place their inked fingers, in order to frighten them sufficiently to prevent them from afterward denying that they had signed them. There seems *then* to have been no idea in Herschel's mind that these marks were individual, or that they could be identified. As might be expected, however, this latter idea developed with the greater familiarity of such "sign-manuals," so that, after using finger prints for a number of years, we find Herschel in 1877 submitting a semi-official report to the Inspector-General of Jails, asking the permission to extend this practice, now become a means of identification, to the prisoners, but without result. Within his own province,

however, he applied the system extensively; to pensioners, to prevent their impersonation by others after their death, in the office for the Registration of Deeds, and to prisoners, to identify them if they should escape.

Unfortunately, during all this time, between 1858 and 1880, while Herschel was employing and extending a simple form of finger print identification, he seems never to have published anything on the subject, so that Faulds was quite justified in considering his letter of Oct. 28, 1880, the first mention of a new idea. Herschel replied at once to the letter of Faulds by another, which appeared in the same periodical on November 22 following, in which he made no claim to priority, but stated as an interesting fact that he had been employing the finger print method "for more than twenty years," and had "introduced them for practical purposes in several ways in India with marked benefit." He then mentioned the three ways enumerated above, which he developed and used practically, describing his experience in the following words: "(1) First I used it for pensioners whose vitality has been a distracting problem to government in all countries. When I found all room for suspicion effectually removed here, I tried it on a larger scale in the several (2) registration offices under me, and here I had the satisfaction of seeing every official and legal agent connected with these offices confess that the use of these signatures lifted off the ugly cloud of suspiciousness which always hangs over such offices in India. It put a summary and absolute stop to the very idea of either personation or repudiation from the moment half a dozen men had made their marks and compared them together. (3) I next introduced them into the jail, where they were not unneeded. On commitment to jail each prisoner had to sign with his finger. Any official visitor to the jail after that could instantly satisfy himself of the identity of the man whom the jailer produced by requiring him to make a signature on the spot and comparing it with that which the books showed."

After a long official experience Herschel adds, in this same letter, "The ease with which the signature is taken and the hopelessness of either personation or repudiation are so great that I sincerely believe that the adoption of the practice in places and professions where such kinds of fraud are rife is a substantial benefit to morality."

In comparing the work of these two men, Faulds and Herschel, and considering the long official employment of a finger-print system by the latter as opposed to a three-years' study of them by the former, it seems but just to agree with Galton that "if the use of finger prints ever becomes of general importance, Sir William Herschel must be regarded as the first who devised a feasible method for regular use, and afterwards officially adopted it." *

If we emphasize Galton's words, "a feasible method for regular use,"

* Galton, "Finger Prints," 1892, pp. 28–29.

this claim may perhaps be allowed, yet it must ever be remembered that Herschel himself never sought personal fame in the matter, and that his claim to preferment was first made, not by himself, but by a generous friend, who built well upon the foundation laid down by Herschel, adding to the use of finger prints by comparison, a system of classification by which those of a given man could be readily found. It thus happens that while the name of Herschel takes its proper place among the pioneers, that of Galton is remembered by a grateful posterity as the founder of our present system of Finger-Print Identification.*

Still, aside from Faulds and Herschel and Galton, there were other men who, at about the same time, were making experiments and observations on the subject, and one at least put the matter to practical use. Thus Galton mentions two Americans, Mr. Tabor, "the eminent photographer of San Francisco," who proposed the use of finger prints for the registration of immigrant Chinese, and Mr. Gilbert Thompson, the geologist, who, while in charge of a Government survey in New Mexico in 1882, employed this method to prevent the forgery of orders on the camp sutler.

Aside from the practical use of finger prints for identification, several anthropologists and anatomists have used various methods for taking prints of palms, soles, and fingers, to be employed as records of the conditions found there. Of these undoubtedly the first was the German anthropologist Hermann Welcker, of the University of Halle, who, in the year 1856, took the print of his right palm. He took a second print of the same in 1897, and published them both the ensuing year.† The first print was taken in his 34th year, the second in his 75th, forty-one years apart, thus spanning a greater interval than any in the possession of Galton. It will be noticed that, as Herschel's first finger print was taken in 1858, the first palm print of Welcker has the priority of two years, yet in Welcker's paper of 1898 there is neither in word nor implication the

*Sir William James Herschel was born in England in 1833, and has just died (Oct. 23, 1917) at his family estate, Lawn Upton, Littlemore, Oxfordshire, England. Last year, as an old man of 83, he published an interesting little book of some 40 pages, with the title "The Origin of Finger Printing," in which he reviews his early work in India in the use of finger prints for the identification of natives. In this he publishes the print of one of his fingers taken in 1858, at the age of 25, and again the same finger at 82, fifty-seven years apart, and without change in the slightest detail. This is undoubtedly the longest interval thus far available for study, surpassing the forty-one of Welcker by sixteen years.

This work of Herschel was unfortunately not available at the time this chapter was written, yet the main facts are presented above. The book is recommended to the interested reader, and furnishes many facts of historic interest in connection with the early development of the system. It is published by the Oxford University Press, London.

† Published in Archiv für Anthropologie, Bd. 25, 1898, pp. 29–32.

slightest claim to this honor, simply the desire to assist in Galton's claims to the unchangeableness of the friction ridges. Thus the name of Hermann Welcker must be added to those who, during the last half of the nineteenth century, strove to exploit the friction-ridge configuration as a method of personal identification.

Although this review hopes to be fairly complete concerning the pioneers among the white race, there are plentiful suggestions of the use of finger prints among the Chinese and Japanese reaching back to an unknown past. One must here distinguish clearly between the use of the ridge markings, as seen in a clear print, and a simple blot or daub, used either by an illiterate person, as we use the cross, or for some superstitious purpose, where the actual contact of the person signing a document is thought to be of avail.* There is, for example, an old Japanese divorce law of China, enacted by the Emperor Taihô in 702 A. D., where the husband was required to sign a document with the print of his index finger; but there is absolutely no indication that this was other than a blot conveyed from the ink (India ink) to the paper by his forefinger. The same may be said of thumb stamps, and nail marks, the latter of which was made in wax or clay with the finger nail, and could have shown nothing of a finger pattern. It is still possible that some Chinese or Japanese antiquary may bring to light some definite proof of the ancient use of true finger patterns, but thus far no such practice has been proven.†

After proving the individuality and the permanance of finger prints, Sir Francis Galton took the next great step, and devised a method of describing and indexing any number of prints, thus rendering possible the

* In Ploss-Bartel's Das Weib, Vol. II, p. 542, there occurs the following:

Speaking of the sale of wives and daughters in China, permissible, although not considered decent or respectable, the authors say:

"Der Vertrag, welcher die Bestimmung des Verkaufs und der Verkaufssumme enthält, wird dann vom Käufer und dem bisherigen Ehemann unterschrieben, und der letztere beschmiert, anstatt das Dokument zu siegeln, die Innenfläche seiner rechten Hand und die Sohle seines rechten Fusses mit Tinte und drück dieses auf den Vertrag, womit die Uebergabe erfolgt ist."

[Translated]. The contract which contains the acknowledgment of the sale and the sum paid is then signed by the purchaser and the former husband, and, instead of sealing the document, the latter smears with ink the inner surface of his right hand and the sole of his right foot, and presses them upon the contract, whereby the transfer is complete. (H. H. W.)

In all the above there seems to be no thought of *identifying* the man who gives his prints; rather it seems a sort of superstition — sanctioning the sale by some bodily contact, like shaking hands upon a sale. If identification were intended, the one to be printed would be the unlucky woman, who is thus made a chattel for sale and exchange, like a slave.

† This subject has received a brief treatment by Minakata, in *Nature*, 1894, pp. 77 and 199, and 1895, p. 274.

search for a single print, or set of prints, in a large collection, and by this means putting the system upon a practical basis (1890-1891). The time was now ready for an inquiry by the British Government as to its feasibility in actual practice, and on Oct. 21, 1893, a committee was appointed for this purpose by the Hon. H. H. Asquith, then Secretary of State for the Home Office. This committee consisted of the following: Charles Edward Troup of the Home Office, Chairman; Harry Butler Simpson of

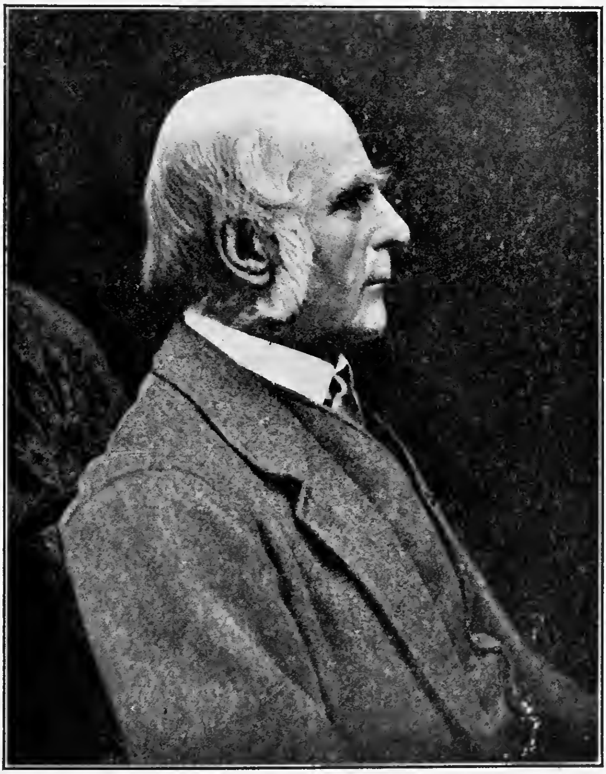


FIGURE 144. Sir Francis Galton (1822–1916). (From Locy: Biology and its Makers, with the author's permission.)

the Home Office, Secretary; Major Arthur Griffiths, Inspector of Prisons; Melville Leslie McNaghten, Chief Constable in the Metropolitan Police Force. (Of these Troup, Griffiths, and McNaghten constituted the committee; Simpson was secretary.)

The committee was charged "to inquire: *a*, into the method of registering and identifying habitual criminals now in use in England; *b*, into the 'anthropometric' system of classified registration and identification in

use in France and other countries; *c*, into the suggested system of identification by means of a record of finger marks: to report to me whether the anthropometric system or the finger-mark system can with advantage be adopted in England either in substitution for, or to supplement, existing methods, and if so, what arrangements should be adopted for putting them into practice, and what rules should be made under Section 8 of the Penal Servitude Act, 1891, for the photographing and measuring of prisoners."

Thus instructed, the committee went immediately to work, and their report appeared on the 12th of February following, as Blue Book C 7,263. The parts that especially interest us are here given, taken from Galton's book, "Finger Print Directories," pp. 7–47, where the report is given practically in full and includes a verbatim report of the interviews between Mr. Galton and the committee.

Concerning Mr. Galton's system and the impression produced by it, the report states: "A visit to Mr. Galton's laboratory is indispensable in order to appreciate the accuracy and clearness with which the finger prints can be taken and the real simplicity of the method. We have during this inquiry paid several visits to Mr. Galton's laboratory; he has given us every possible assistance in discussing the details of the method and in further investigating certain points which seemed to us to require elucidation. He also accompanied us with his assistant to Pentonville Prison, and superintended the taking of the finger prints of more than a hundred prisoners."

After this practical experience with prints, and after receiving the explanation of the system from the inventor, the committee states: "It seems impossible to insist too strongly on the absolute certainty of the criterion of identity afforded by the finger prints. Considered merely as a test of identity . . . their use becomes at once extremely simple, and in the hands of an expert free from any danger of error. . . . If the prints of three fingers only of every criminal prisoner were taken before his discharge, and kept with his papers in the prison, it would be impossible afterwards wrongly to attribute the conviction to any other person. . . . So if the finger prints of pensioners were taken and kept with their papers, an absolute test would be available if any question of fraudulent drawing of the pension (*e. g.*, after the death of the pensioner) should ever arise."

In weighing the relative value for practical purposes of the various systems investigated, three principles were laid down by the committee:

"1. The descriptions, measurements, or marks, which are the basis of the system, must be such as can be taken readily and with sufficient accuracy by prison wardens or police officers of ordinary intelligence.

"2. The classification of the descriptions must be such that on the

arrest of an old offender who gives a false name his record may be found readily and with certainty.

"3. When the case has been found among the classified descriptions, it is desirable that convincing evidence of identity should be afforded."

Applying these rules to the various systems investigated, including ordinary descriptive methods, the Bertillon system of measurements, and the new finger-print system of Galton, the committee declared:

"The first and third of these conditions are met with completely by Mr. Galton's finger-print method. The taking of finger prints is an easy mechanical process which with very short instruction could be performed by any prison warden. While in M. Bertillon's system a margin greater or less has always to be allowed for errors on the part of the operator, no such allowance has to be made in Mr. Galton's. Finger prints are an absolute impression taken directly from the body itself; if a print be taken at all it must necessarily be correct. . . . The committee were so much impressed by the excellence of Mr. Galton's system in completely answering these conditions [*i. e.*, the three given above] that *they would have been glad if, going beyond Mr. Galton's own suggestion, they could have adopted his system as the sole basis of identification.*"

While the real feeling of the committee was expressed by the above statement, which we have put into italics, yet, for the sake of the general public, they recommended the retention of the existing methods, to which the finger-print system should be supplementary "at least for a long time to come," the definite proposition being:

"1. To photograph them as at present.

"2. To take the five measurements required for purposes of classification; viz., the length of the head, the width of the head, the length of the left middle finger, the length of the left forearm, the length of the left foot.

"3. To take the finger prints by Mr. Galton's method.

"4. A description should also be taken as at present, but somewhat briefer, including the height in feet and inches, colour of hair, eye, and complexion, and the distinctive marks."

The conservativeness of this final recommendation is explained by the remark: "This is not required for the purpose of classification; but it is necessary (*a*) in case the arrest of the criminal should be required while he is at large, and his description has to be published for this purpose; (*b*) in case his identity should be disputed, when the distinctive marks often supply the evidence which can most easily and most satisfactorily be put before a jury."

The committee further recommended that this proposed register be

placed at Scotland Yard rather than in the Home Office. It finally expresses the belief that it will take some years to fully establish the Galton system, "or any other scientific method that may be adopted," and that the full results may not be expected for some time; it is hoped also that, after the establishment of the finger-print system in England, it "may speedily be extended to Scotland and to Ireland."

Thus the finger-print system became officially established in England, the date being considered, perhaps, as that of the issuance of the above report, Feb. 12, 1894. By the same report the inventor was acknowledged as Sir Francis Galton of London, first cousin to Charles Darwin, and at the time of the interview with the committee, in his seventy-second year. Already a man of note for biological research, especially in the study of heredity, he crowned the labors of a long lifetime by this great gift to all humanity, and takes his place among the roll of England's great old men, as a worthy member of that company.

To carry out the recommendation of the committee, who recommended the retention of the Bertillon system as the principal system, and to introduce this new method of Galton's as subsidiary, Mr. Asquith appointed Dr. J. G. Garson as the expert to organize the introduction of the new system in its subordinate position. Dr. Garson's full title in this new office was "Expert Adviser and Instructor on Identification," and he served in this capacity until about 1901.*

Dr. Garson had studied the Bertillon system in Paris, with the inventor himself, and was naturally strongly prejudiced in favor of it. Working with the finger-print system as a useful adjunct to measurements, he prepared a practical method of applying it, and presented the same to the British Association for the Advancement of Science at their meeting at Bradford, in 1900. This method, or system was, to use his own words, "devised to be worked in conjunction with classification of records by measurement of the head and limbs for the purpose of facilitating search for previous records of criminals." This system naturally had but a short life, since the appointment of Sir Edward Richard Henry as the Assistant Commissioner of Police at New Scotland Yard took place the following year (1901), but it is of considerable historical interest and a short descr ption of it in this place would not be amiss. It is to be re-

* Garson seems always favorable to the finger-print system, but was very naturally prejudiced in favor of the measurement system, which he had learned directly from the inventor. He acknowledges that the finger prints furnish "a test which, in the hands of a skilled person, would be unimpeachable," yet finds practical difficulties notwithstanding, as he says, "the labours of Mr. Galton and Mr. Henry, and, to a smaller extent, my own endeavours in that direction." To him these difficulties were so great "as to prevent a thoroughly satisfactory system, workable on the large scale we require in criminal work, without the assistance of measurements, from ever being possible."

membered that, as a subsidiary system, it was to be employed merely as a convenient means of separating rather small groups, and would not be large or comprehensive enough to be used as the only classification in large collections.

In the first place, Garson, like Galton and others, recognized four types of finger pattern, and used symbols to represent them.

An arch, thus	∧
A loop which opens on the left	/
A loop opening to the right	\
A whorl of any kind	O

He used only the first four digits of the *right* hand and thus the "loop which opens on the left" means a *radial* loop, and the one opening to the right an *ulnar*, as these directions refer to the patterns as they are seen on a print rather than on the hand.

The first classification is that of the *right thumb;* Class A, includes arches and all kinds of loops, and Class B whorls with their varieties. Each of these two classes is further subdivided into four smaller groups by the pattern on the *index finger*, here using all four types, as given above. That is, Group *a* includes arches only, Group *b* ulnar loops, Group *c* radial loops, and Group *d* whorls. This subdivision into four of each of the two initial classes makes in all eight groups, as follows:

A a	B a
A b	B b
A c	B c
A d	B d

Of these eight groups A c and B d alone are inconveniently large, and each of these is further subdivided in its own way. The first, A c, is divided into two approximately equal groups by separating those cases in which all four of the fingers used, thumb, index, middle, and ring fingers bear ulnar loops from those in which other patterns occur. B d is separated on quite different grounds, namely, by the pattern on the middle finger, whether it has (1) a whorl, or (2) any of the other three. Cases including lost fingers are filed with B a, as this group is a little smaller than the rest.

As this system furnishes five A groups and five B groups, or ten in all, it can be used to divide each of the 81 Bertillon divisions into ten, thus making 810 divisions; or, when using 243 Bertillon divisions, the full capacity of the system, the divisions will be increased to 2,430.

This system, based on practical considerations, and devised with special regard to an equality of the divisions, had no chance of surviving, for such was the march of events that the complete adequacy of the finger-

print system alone became so quickly established that no one cared to adopt, or longer to use, a system based primarily upon bodily measurements.

In 1893, the year in which Sir H. H. Asquith appointed his committee to investigate the finger-print system, appeared the first edition of the definite work of Alphonse Bertillon, a manual of the system of identification by bodily measurements, supplemented by careful details of facial features and bodily marks. This is the system of "Bertillonage," as

FIGURE 145. Alphonse Bertillon (1853–1914). From an early photograph.

the French term it, and it is important to note, in order to correct a common error, *that it has nothing whatever to do with finger prints or with any part of the friction skin.* As a matter of fact Bertillon did not believe in the possibility of the practical use of finger prints, because of the great difficulty of finding a means of classifying a large collection of them. In this book of 1893, indeed, he says expressly, "Unfortunately it is quite undeniable, notwithstanding the indefatigable researches of Mr. Francis Galton in England, that these designs do not present in themselves elements of variability sufficiently striking to serve as a basis in a collection of many hundreds of thousands of cases." *

* "Malheureusement il est tout aussi indéniable, malgré les recherches ingénieuses poursuivies par M. Francis Galton, en Angleterre, que ces dessins ne présentent pas par eux-mêmes des éléments de variabilité assez tranchés pour servir de base à un répertoire de plusieurs centaines de mille cas."

Nothing can better show the greatness and broadmindedness of Bertillon than the fact that within two years after writing the above he had added to his descriptive cards a blank for finger prints, having become convinced of the efficacy of the system. Indeed it was his very advocacy of this new system, the invention of a foreigner, that rendered the idea current in the United States that Bertillon was himself the inventor, and has made the present explanation necessary. To show Bertillon's early and

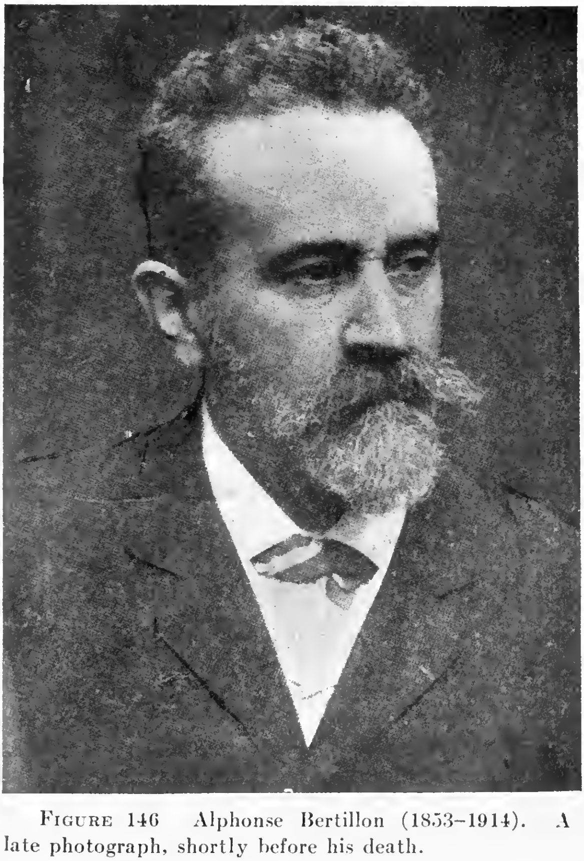


FIGURE 146 Alphonse Bertillon (1853–1914). A late photograph, shortly before his death.

complete adoption of the Galton system, we give here one side of one of his own descriptive cards, bearing the finger prints of the right hand, and the date of August 27, 1895. Upon the reverse are found the name and other particulars, a list of marks and scars, and the finger prints of the left hand.

Aside from the rapid adoption of the finger-print system for practical purposes, following the favorable report of the English committee, finger prints began to appear in fiction, and in 1894, with his accustomed enterprise, Mark Twain appeared before a larger public with his "Pudden-

head Wilson." Had this genial character of fiction been real, he would easily have been the inventor of the system, and even as it is, there are still some minds in whom lurks the suspicion that in some way Mark Twain had much to do with devising the "thumb mark." Still, although we

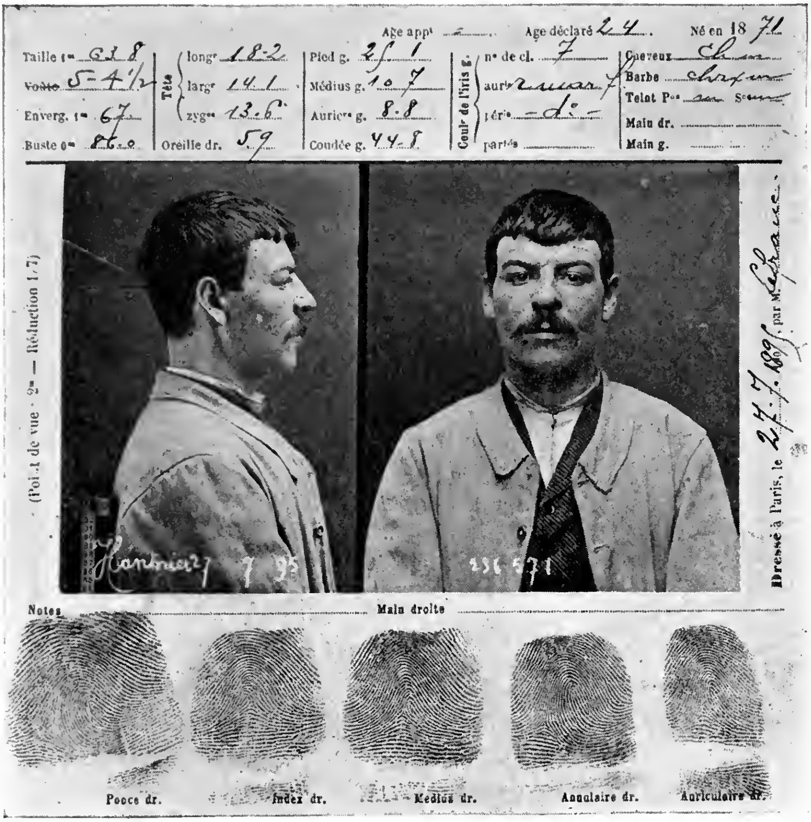


FIGURE 147. Signalement card from the prefecture of Police, Paris, bearing the date of July 27, 1895, and showing the form used soon after the adoption of the finger prints. Those of the right hand are seen on the face, the prints of the left hand are on the back, in a reverse position to those of the right hand. This illustration reduced ¼.

cannot give him credit for this, what Mr. Clemens really did do was to spread among the people correct ideas concerning the new system, and thus became a true "prophet to the Gentiles" in the subject.

While Galton invented it, Bertillon promulgated it, and Mark Twain interested the public in its possibilities, the finger-print system was still rather heavy and cumbersome, and needed a further simplification, a final touch, to render it easily applicable to police headquarters everywhere. This simplification was the work of Sir Edward Richard Henry, who

gained his spurs as Assistant Collector of Bengal, colleague and successor of Sir William Herschel. In 1899 Henry presented his simplified system, elaborated in India, before the Dover meeting of the British Association for the Advancement of Science, and in 1900 he published it in book form, the first of many editions and a standard work on the subject.* (See frontispiece.)

Henry was called to London in 1901, as assistant commissioner of police, with headquarters at New Scotland Yard, where he is at the present writing the acknowledged head of the system of finger prints. It is with great pleasure that we here speak of the many ways in which he has assisted us in the preparation of this book, both by genuine interest and encouragement, and by much valuable material aid in furnishing illustrative cases. No less than Herschel, Galton and Bertillon, to whom he is a worthy successor, he is a thorough scientific investigator, seeking the best and most complete methods, irrespective of the source from which it comes. It is through this line of worthy investigators, to whom the truth is far above individual interests, that this great gift of being able to fix an individual identification without the shadow of a doubt has been transmitted to humanity.

As a definite rival to the British school of dactyloscopy may be cited the labors of Juan Vucetich in Argentina, where finger-print identification has progressed further than in English-speaking countries. It is claimed that Vucetich had printed and classified the finger prints of many criminals previous to September 1, 1891, and that on this date he made his first finger-print identification. If that can be substantiated, and this is practically certain, the first actual use of finger prints in identification should be credited to Vucetich, who thus seems to have made *the first finger-print identification in the world* at the time when Galton was ready to submit to an investigation. †

* A review of the presentation at Dover is found in *Nature*, Vol. 61, November 9, 1900, and is there called "the chief point of interest on the first day of the meeting, apart from the president's address." The book of the following year bore the title, "Classification and Uses of Finger Prints," the same as in the later editions.

† Vucetich, Juan; Conferenzia sobre el sistema dactyloscopioo, dada en la Bibliotheca publica de la Plata. Publ. at La Plata in 1901.

Vucetich, Juan; Dactyloscopia comparada. Publ. at La Plata, 1904.

The perfection in the use of the finger-print system of Vucetich in Argentina was brought out by an article in the Brooklyn *Eagle* for January 28, 1917. Every able-bodied man, when he enters for the military service, is finger-printed and photographed by the Bertillon method (front and side). These data are pasted into a little book, which is kept permanently by the man who is thus described. After this it is used, and its use is required, at each important business transaction, including the obtaining of a marriage license. The book is a certificate of good citizenship, and when a man commits a crime his book is taken away from him. Thus the main use of finger-print identification is for civil purposes, and the connection with criminal prosecutions is quite secondary. (G. T. M.)

CHAPTER XI

PRESENT USE OF FRICTION-RIDGE IDENTIFICATION; POSSIBILITIES FOR THE FUTURE

"I am sanguine that the careful study of these patterns may be useful in several ways. . . . When bloody finger-marks, or impressions on clay, glass, etc., exist, they may lead to the scientific identification of criminals. . . . Other cases might occur in medico-legal investigations, as when the hands only of some mutilated victim were found. If previously known they would be much more precise in value than the standard MOLE *of the penny novelists. If unknown previously, heredity might enable an expert to determine the relative with considerable probability in many cases, and with absolute precision in some. Such a case as that of the Claimant [Tichborne] even might not be beyond the range of this principle. There might be a recognized Tichborne type, and there might be an Orton type, to one or other of which experts might relate the case."— Dr. Henry Faulds, in* NATURE, *Vol. XXII, p. 605, October 28, 1880.*

IT is not a little singular that the one who was the first in modern times to suggest in print the use of finger prints for identification purposes, saw, at the same time, a wider application of a system so based than did his contemporaries. Yet, as shown in the previous chapter, Dr. Faulds, in the same short letter in which he suggested the use of finger prints for the usual form of identification, mentioned also, in addition to certain directions of thought important to the biologist and ethnologist, the identification of severed members, and the tracing of relationship by the continuance, through heredity, of characteristic configuration.

While in the suggestions of Faulds there are some that seem at present to be rather visionary, there are others, notably the identification of a criminal by accidental finger impressions left at the scene of the crime, which have been abundantly verified. By the introduction of the entire palm and the sole into the system the identification of a man, not only by a severed member, but at times by even a small fragment of friction skin, becomes a possibility soon to be realized. Later research into the heredity of the finger patterns does not furnish sufficiently positive results to promise much; yet, when dealing with the larger and more striking features of the palms and soles, certain heredity characters often appear with marked distinctness, and may be of use in furnishing good presumptive evidence either for or against near relationship.

As has been shown, the finger-print system was first officially used in India, and was applied to the identification of the signers of various sorts of papers, especially deeds and pension papers. From this it was an easy transition to the identification of professional criminals, and the addition of a set of finger prints to the photograph and other data in the possession of the police. It was seemingly with this latter use in mind as the chief application of the system that the British committee of October, 1893, was appointed, although, both in the appointment and in the official report, identification was also spoken of without qualification.

As soon as the system was incorporated, however, there appeared an unexpected application, namely, that of tracing the agent of a crime by accidental finger marks left on the spot, especially those to be found on glass, polished furniture, and other smooth surfaces. The remarkable results of this discovery, resulting in the conviction of the criminal in numberless cases where otherwise there would have been no definite clue, are now so much matters of common knowledge that there exists a popular error to the effect that this is the sole, or at least the chief, use of the finger-print system, while the purpose for which it was originally advocated is more or less forgotten. Perhaps the most flattering tribute to this form of application of the system comes from the criminals themselves, who have now taken to the wearing of gloves while engaged in their professional work.

In view of such response on the part of the criminals to baffle the finger-print clue left by accidental impressions, it cannot be too strongly emphasized that the primary purpose of the system is to identify persons actually under scrutiny, and that in this work it is of such great importance that, even with the elimination of accidental prints altogether, its usefulness would be but little impaired. Scotland Yard, during the first thirteen years in which the finger-print system was in use, had made some 91,000 identifications, without a single error. Some of these are, undoubtedly, cases of identification through accidental marks, yet the vast majority are direct identifications, that is, of men actually in the hands of the police, who deny their identity.

Naturally the application of the finger-print system to the identification of criminals at first rather prejudiced the minds of the public to its use for various civil purposes, yet it has gradually made its way in other directions. Certain of these other uses, either already adopted or to be contemplated for the future, are here considered.

1. *Bank Identification.* In banks there are several ways in which a definite identification is necessary or advantageous, such as the identification of strangers who present checks for payment, and other clients; there is also the safeguarding of personal checks and other papers. Several outfits for the use of banks have already been devised, based of course

on the existing system, and consisting mainly of a mahogany box, a small piece of plate glass, and other appurtenances, and with this comes, after the payment of a certain sum for private instruction, the explanation of a part of the well-known method of indexing, as given here, with a guarantee of secrecy on the part of the purchaser. This last, in view of the complete publicity of the whole system from the beginning, seems rather superfluous. Naturally, however, all these systems are good, since they are taken directly from the approved methods.

It is to this source, that of banks and their needs, that we are indebted for a recent advance in the technique of taking finger prints, a technique which will rid the process of the only possible disagreeable feature, that

FIGURE 148. Plain impression of the right index, middle, and ring fingers, as used by banks at the present time.

of the use of printing ink. This advance comes from Mr. Ray E. Bauder, cashier of the First National Bank of Taylorville, Ill., and consists of the use of a card, sensitized chemically, and developed and fixed much after the manner of a photograph. This system has already been adopted in nearly all the larger banks in Chicago, and is employed by the Chicago Police Department. Aside from the usual form of records, Mr. Bauder has devised two other applications. One of these is an identification card, which is to be issued only through a bank to its clients, and designed to identify him while traveling. It consists of a small card, marked with the name and any other devices of the bank, and bearing the signed autograph and the usual three finger prints (right index, middle and ring), of the client. The other device or form of application is for bank checks, to prevent either forgery or any attempt to raise the amount. In the one case the imprint of the three fingers is placed in the area for the signature, and written over with an ink that bites through the fiber of the

paper; in the other the print of the thumb alone underlies the numerical expression of the amount.

Without wishing for a moment to belittle the conveniences furnished by the various firms who prepare outfits for banks and other places, it should be noticed that the finger-print system, as employed the world over, is based upon natural features, and has been elaborated by scientific men who have carried on their researches for the love of knowledge and have given their results to the world without restriction. While the various improvements in outfit and method may fully repay the small

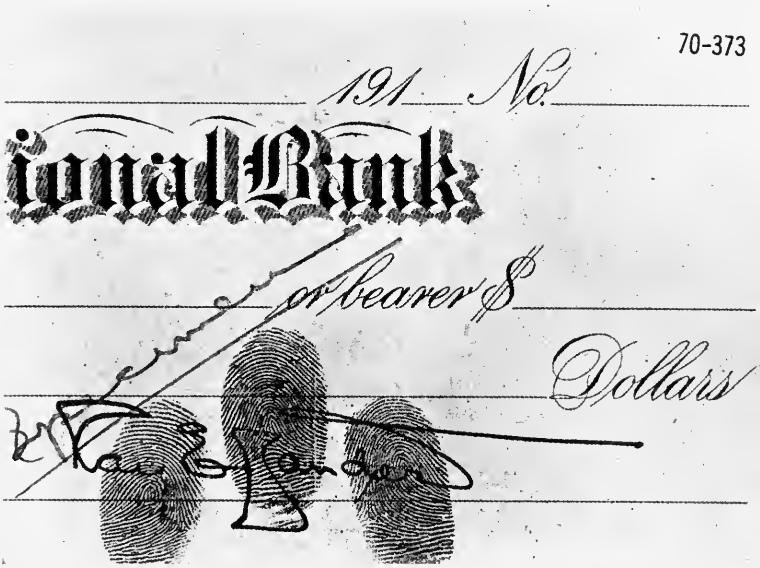


FIGURE 149. Check signed by the usual three fingers, and surcharged with the signature. The fingers are printed by the Bauder method.

cost of installation, nothing more is really necessary for an effective system than a piece of glass, a small rubber roller, some printing ink and paper, and a slight knowledge of the system in general use, fully explained in any one of a considerable number of available books, found in any large library.

The need of such a system for the identification of those with whom the banks have to deal is apparent on the face of it, and especially is it valuable in case of the small depositors in savings banks, many of whom are more or less illiterate. Add to this the considerable proportion of foreign names, which, in some cases, the depositors themselves cannot spell, and the chance of error becomes very great, relying upon the customary methods

alone. A rather unusual case, involving the identity of a depositor, has recently been cleared up by the use of the finger-print record.

A certain Mrs. D., a Polish woman, reported at the police station of her city that some one had entered her tenement that morning while she was away, and had stolen $40 in cash and a bank-book containing a deposit record of $120. Her husband sent to the bank to see about the deposit, reported to his wife that it had been already withdrawn. The inspector, suspecting fraud, took the husband's finger prints, and found

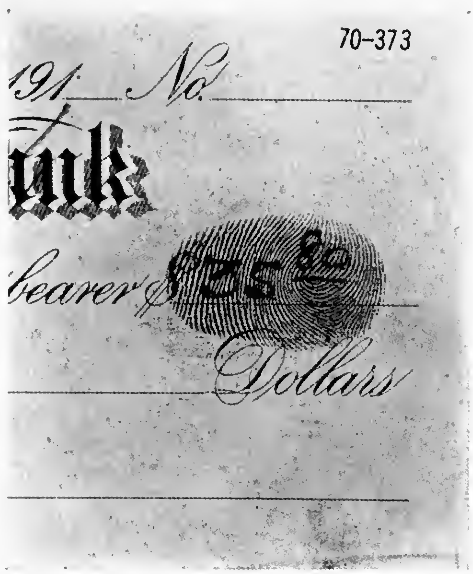


FIGURE 150. Thumb print used as a background for the sum for which a check is drawn. This will prove the identity of the writer of the check, and at the same time prevent any alteration in the figures. Sample of the Bauder method.

them identical, both with those registered at the bank and with those of the man who had presented the book and withdrawn the money. The man had thus withdrawn his own money, but had attempted both to deceive his wife and to defraud the bank, as he stoutly denied having withdrawn the sum, and demanded that he be given the amount of the original deposit. As a man has, naturally, the right to withdraw his own money, the case was dropped; yet, had not the bank previously installed the finger-print system, the case would have been very hard to settle.

2. *Identification of Bodies, when records have been previously taken, and are available.* Naturally any system based upon the friction skin

whether it be finger prints or the larger areas of the palms or soles, is entirely independent of the sentience or the life of the body to be identified, and thus a dead body, or even a severed hand or foot, can be identified if it happens to have belonged to a man whose records have once been filed. Since, in addition to criminals, the United States now keeps the finger-print records of its enlisted men, the number of men thus identifiable is already fairly large, and is constantly increasing. Should it happen, then, that a body is that of either a recorded criminal, or an enlisted soldier or sailor, its positive identification is simply a matter of looking up the records. Some time ago the body of a man clothed only in an undershirt was found floating in the Hudson River opposite Fort Lee. It was badly swollen and difficult or impossible to identify by usual means, but a slight clue was afforded by the make of the undershirt, which was like those issued by the United States Government to its soldiers. As the lines of the swollen fingers would not register on paper, a skilled surgeon and an embalming expert took the body in hand, extracted the water from the finger ends, and substituted a hardening fluid. Prints were thus easily taken, and sent to the War Department at Washington. A short search resulted in finding the duplicates, and showed the victim to have been a corporal trom Fort Totten. He had gone off on leave several weeks before, with two months' pay in his pockets, and had been robbed on board some steamer and thrown overboard. The finger prints completely established his identity, and the body was given Christian burial. Elsewhere we have recorded a similar identification in the Navy Department, and the reader will also recall the unique case of the torn-off little finger left on a gate spike, a case identified by Scotland Yard. All of these cases treat of either criminals or members of the army, where their finger prints were on file and easily available; yet, should each municipality keep a similar record of each of its citizens, or, still better, a *complete* record, including palm and sole prints, all would be capable of positive identification, even in cases of the gravest accidents, where the bodies were badly mutilated, or actually dismembered. Even while we write this, there appears in the daily papers an account of a mutilated body found in a river flowing near one of our largest cities. This is described as "the body of a man, evidently wealthy and refined. . . . There were two gunshot wounds below the heart. The throat had been cut, the nose smashed with a heavy instrument and the face criss-crossed with knife hackings. The whole body had been hacked and beaten, and finally a clumsy effort had been made to embalm it. All identifying marks on the clothing had been ripped off." If this city possessed a long-established identification bureau, recording all of its inhabitants at school age, this body could be at once identified, had he been an inhabitant, which was likely. If he had been a stranger, the problem would be confessedly

harder, yet, with a similar system covering the entire country, the general publication of the descriptive formula of the body, including the finger prints, palms, and soles, would bring a response within a day or two. The identification would be absolute; people who had some friend missing would be spared the anxieties of baffled hopes, or the mental and physical strain of a visit to the morgue. Even at the present time, and with our present equipment for identification, if this body should happen to be that of a professional criminal or an enlisted soldier or sailor, such an identification could be made, but for a citizen belonging to neither of these classes there is no provision.

A short time before writing this it was being reported in the daily press of the country that the Mexican bandit, Pancho Villa, for whose capture the government sent out an expeditionary force, had died of his wounds, and that his body was likely to be brought to the United States troops for the sake of the reward for the man, "dead or alive." There was much discussion as to whether the body, wasted by suffering, yet swollen by decomposition, and conveyed by rough methods over rough country, could be positively identified, and yet the case was a grave one, and the issue of peace or war between two countries might hang upon the decision. Yet, if prints of the bandit's palms and soles were available, or could be furnished by the Mexican Government, and placed beyond suspicion, this critical point could be determined in a few moments.

3. *Identification in Cases of Lost Identity.* Most of the hospitals in the larger cities are well acquainted with cases of this sort. An individual may be seen in the street "acting queerly," or found unconscious, and after treatment may be quite unable to recall name or place of residence. Occasionally this condition may persist for years, the patient meanwhile showing no symptom of derangement save that of a more or less total loss of memory. These cases are, fortunately, rare, yet they do occur, and offer a distinct class of cases that could be much alleviated by the establishment of the identification system here advocated. As in the case of a dead body, the hands would be sufficient to give the name and address of such a patient, and his friends could be readily notified. Such cases are often due to paralysis, which here affects the mechanism for speech or memory, or both; in other cases the disturbance is less fundamental, and results from a temporary lack of function due to the exhaustion of the parts. In one case a man may be found wandering about the street, in great mental distress, because he wishes to find his home but has forgotten where he lives, and even his name; in another the man is speechless, and can tell nothing. In 1910 an American was found wandering along the banks of the Thames, in London, unable to give a coherent account of himself. After being in a hospital for two weeks he uttered the name "Drexel," which appeared to be a clue. The news

of this case came to the attention of a woman in Massachusetts, whose son had disappeared on the eve of his wedding, a few weeks previous, and who recalled that at the time he had talked with her about the Drexel-Gould wedding, and had perhaps remembered the connection. She immediately communicated with the London hospital, and recovered her son, who gradually came to the full recollection of his past estate.

A more serious case was that of the famous "J. C. R.," a man who in 1906 became paralyzed, while sitting in his chair on a train, en route from Minneapolis to Chicago. He was taken out at a way station in Wisconsin, and eventually settled down in this place, being perfectly normal in every respect save that he could recall nothing of the past, not even his own name. He was referred to as "J. C. R.," because these were the initials in his watch. In 1914, while in Chicago, he received a similar stroke, and was taken to Rush Medical College, where he was identified by his mother, who had last heard of him when he was about to start home from Minneapolis on that ill-fated journey, eight years before.

In both this class of cases, and in the identification of mutilated bodies, there is great need of a positive identification as soon as found, both for legal purposes, in case of property, and to relieve the suspense of the friends. Where the man is alive, but the identity lost, there is the added claim of the patient himself to be restored to his family.

4. *Identification of the Babies in Maternity Hospitals.* Here, and perhaps also, although to a lesser extent, in creches and day nurseries, there is need of some means of absolute identification, by which the different children may be definitely recorded beyond the possibility of error. At present each child born in a reputable hospital has a piece of tape, bearing the same number as that given the mother, tied to the wrist. The identification is further safeguarded, as a rule, by the attachment to the back of a small patch of surgeons' plaster, marked in the same way. With even these precautions, however, there is still a possibility of confusion, especially in case the babies are bathed or fed together, or otherwise taken from the side of the mother.

With the introduction and spread of the present identification system through friction-skin configuration, some application of it in such hospitals is to be expected, and we are pleased to record here that pioneers in this field have already appeared in at least two places, Chicago and New York. In the former city the idea has been carried out by the Superintendent of the Chicago Lying-in Hospital, Miss Jennie Christie, assisted by the chief nurse of the birth room, Miss Mabel Carmon. Seeing the impracticality of obtaining legible prints from the fingers or even the palms, Miss Christie uses the soles, which remain fairly flat under all the muscular action of the infant, and cannot, moreover, be covered by the toes, as the palms can easily be by the fingers. Thus far, however, no

definite attempt has been made to *classify* these sole prints, as it is sufficient, in keeping track of the constantly changing infant population, to make at the most one or two comparisons, in order to settle any doubt that may arise.

In New York much interest has been felt in this problem of the identification of infants on the part of the police department. Inspector Faurot, when interviewed in November, 1915, gave as his decided opinion that "impressions of the fingers of both mother and child should be made at the time of the child's birth. . . . It is only one feature of the finger-print system, but it is an important one. . . . It will insure that the mother, between the time of her confinement and the time when she is strong enough to receive the child, a time that is often fraught with grave fears, will be given her own child. No one, of course, knows how often, through mistakes and carelessness, the mother is given the wrong child, but it is safe to say such mistakes occur only too often."* He then, in the same interview, suggested the use of the sole in the identification of infants, as a part "which bears as distinct marks of identification as the fingers," and then outlined the possibility of establishing a Bureau for Universal Identification, like the one proposed by us some years ago.†

At the same time with the experiments of Miss Christie, and the suggestions of Inspector Faurot, Mr. G. Tyler Mairs, a finger-print expert, was also experimenting with possible records which could be taken from babies. He was led by his experiences to reject the use of finger prints altogether, owing to mechanical disadvantages, and, while he thought of the palms as possible, to advocate the soles as by far the most practicable, owing to their relative immobility, and the lack of interference with the work on the part of the toes. Thus, on October 30, 1915, he wrote the authors concerning his experiences: "It is practically out of the question to get a *good full* set of baby's finger prints because of the incessant activity of the subject. This applies also to the palms, so that it seems to me recourse will have to be taken to the sole of the foot. I have experimented in a baby clinic on the fingers and palms, but did not try the feet." Again, on December 9 of the same year, he writes: "In trying to take baby finger prints, the handicap seems to be a mechanical one, because of the great activity of the fingers, and their very small size, especially the little finger. Then there are ten operations, instead of two, as with the palms. Unless you get *all ten* full enough to classify, the print is a failure for *future* use."

It thus seems certain that for the identification of infants the sole, and the sole alone, may be practicable. The method of classifying sole

* Boston *Post* November 26, 1915.

† *Popular Science Monthly*, September, 1903.

prints, as given in Chapter IV of this Part, may be of value, especially as it depends upon the larger and more obvious features, which even in the case of such delicate impressions are usually clear and easily made out. In our experience with baby prints, as in all cases where the skin is soft and the ridges fine and delicate, the best prints are made by the use of a minimum amount of ink, and by barely touching the surface of the flesh to the paper. Such prints are naturally very light in color, but the details of the ridges are much plainer.

5. *Identification of Lost Children.* This topic is akin to the last, and refers to cases where, through various causes, children become separated from their natural guardians. This frequently happens through fires or panics; it occurs occasionally through the child's volition, who runs away from home; in rare cases, too, outside of fiction, a child does get actually kidnapped, for one cause or another. In such cases the return of the child may be long delayed, even until the child's maturity, thus giving excellent opportunity to adventurers for fraudulent substitution or impersonation. It is thus a matter of as much moment to prove that a given person is not the lost child, as that it is; and there are, perhaps, more opportunities to make a negative, than a positive, proof.

Those whose memory goes back to the famous case of Charlie Ross, remember the numerous candidates, some put forward seriously, and some with intent to deceive; and all of these aspirants had to be looked over and personally interviewed by the unhappy parents. If, now, there had been a previous record of the boy, either of the fingers, the palms, or the soles, taken either at the institution where he was born, by the attendant physician at his birth, by some central bureau in his town or county, or, finally, by his parents and kept among the family papers, all this anxiety and annoyance could have been spared. Without fear of even an attempted impersonation, the prints of the lost boy could have been spread broadcast, and each case, wherever reported, could have been looked up by the local authorities, and the case settled, one way or the other, in a few minutes.

This case, although, largely through the press, it acquired a nation-wide notoriety, is not an isolated one, and there is perhaps no time when there is not at least one missing child looked for by the police of the country. Thus, in the papers of April 15, 1916, we read that a boy has been seen in a Gypsy camp near Providence, R. I., and that it is suspected that he may be the missing J —— G ——, who disappeared from his home in —— about six months ago. Naturally it is not expected that finger prints of the missing boy are anywhere available, yet if the family had such in their possession, a positive identification either one way or the other could be made of this boy in five minutes, without the co-operation of any of the relatives.

6. *For Use upon Passports, Travelers' Cards, Travelers' Checks*, etc. In September, 1915, Mr. Kunugi, a prominent Japanese merchant of Santa Monica, Cal., found it necessary to return to Japan, and remain there six months, in order to administer the estate of his late father, in the city of Kofu. Wishing to return to the United States when these affairs were settled, and be under no embarrassment upon returning, he applied to the police of Santa Monica, and received from them an identification card. This read as follows:

Police Headquarters, Santa Monica, Cal., Sept. 23, 1915.

"To whom it may concern:

"The bearer of this letter, Mr. Harry Kunugi, a native of Japan, has been a student and merchant in the United States for the past nine years. He bears an excellent reputation for honesty and integrity, and his continued success and worthy ambitions are deserving of the highest commendation.

"Mr. Kunugi has just received notice from his native city, Kofu, Japan, that his presence there is necessary in order to administer the estate of his late father. He expects to be absent about six months and will be accompanied by his two-year-old daughter Alice.

"To prevent any mistake arising in regard to the identity of Mr. Kunugi or his daughter, either in Japan or upon returning to the United States, a description, together with photographs and finger impressions of both appear hereon.

"E. E. Randall, Chief of Police."

This is probably the first instance of the use of such an identification card, but, with a duplicate filed at the Santa Monica office, every possibility of faulty identification would seem to be removed. The instance illustrates the use of an infant's prints as well as that of an adult; Mr. Kunugi would be able to match the impressions on the card with his own finger bulbs whenever required; and the only possible source of error, the manufacture by the bearer himself of a forged card, that is, a card not issued by the police headquarters, could be checked at once by application to said office.

Such a card, issued by the State Department at Washington, would form a passport of much greater value than any of our present forms, provided only some method could be devised whereby the proof would appear that the prints were made in the presence of the proper officials. This could be effected with a fair amount of safety from forgery by surcharging the prints with the official signatures, that is, by first taking a print covering a large area, either by the use of the full set of finger prints, or by that of an entire palm, and then placing the necessary signatures

directly upon the printed surface. If duplicate prints were retained by the State Department fraud would become impossible.

By the similar employment of a single print, that of the right thumb, for example, surcharged with the signature, travelers' checks could be issued with much greater safety.

This surcharging of a print by a signature is no new idea, but is recorded by Galton (1892, p. 27) as having been employed by the American geologist Gilbert Thompson, while on a government survey of New Mexico in 1882. Here the matter concerned orders on the camp sutler, made out by him, which would allow the recipient to draw on the supplies. He placed his own thumb mark on each order, and surcharged it with his personal signature. The case is thus a distinct application of the system, since in the other instances here treated the print is that of the holder of the paper, while the surcharging signature is that of the official granting the privilege.

7. *Pensioners and other Beneficiaries, who are paid at definite intervals.* Here there is no question of forgery, since the finger print or palm print records would be kept at the office of the agent disbursing the funds, and the beneficiary could be asked to prove his identity by signing the receipt with his thumb or other finger. This was the earliest use of finger prints as employed in India by Sir William Herschel, and has been independently devised elsewhere for this and similar purposes.

It is essentially the same as the identification of depositors in banks, treated above, and represents the same method, applied to a different class of subjects.

8. *Identification of Chinese Coolies, or of Undersirable Immigrants, which have once been rejected.* These classes of subjects are again essentially similar in treatment to bank depositors, for in all the question concerns the *recognition of persons previously recorded.* In application it is thus also the same as the system employed for the recognition of old offenders in the police courts. Because of this last association there has already been some opposition on the part of the public, yet the same objection might be urged against the statements concerning the color of hair and eyes, or the use of the photograph, employed the world over on passports, commuters' tickets, and the like, and should not be considered seriously. At this writing a popular agitation has been worked up against the New York police, because of their action in "finger-printing" some boys who were caught playing ball in the street. As a matter of fact, their misdemeanor, although not a serious one, was technically sufficient to get the boys before a certain magistrate, and the taking of the prints was no more than taking their names and addresses. It simply served to identify, and neither has, nor in itself suggests, anything of a criminal nature.

Chinese are proverbially difficult of identification by the ordinary facial recognition, and even the use of photographs does not always prove conclusive. The same is true of negroes, and of all peoples of a race unlike that of the examiner, where the racial characters stand out so sharply as to obscure the finer details upon which recognition largely depends.

Undesirable immigrants, if very persistent, are liable to try a second time to enter the United States, relying upon non-recognition and the greater leniency of a new set of officials, but if all rejected cases were recorded by fingers or palms, and the formulæ for these were recorded at all the ports of entry, the fact of a previous arrival would be definitely established.

9. *Identification in the Army and Navy.* The present use of finger prints in recording all enlisted men in the United States army and navy has been already alluded to above, in the case of a mutilated body. Aside from such sporadic instances one thinks immediately in this connection of the ravages of modern warfare, and the enormous heaps of mutilated slain, where identity is considered hopeless. Even as long ago as the Franco-German war, Bismarck relates seeing a long row of carts, coming from the front, loaded with merely the trunks of dead men, without either heads, arms, or legs, and quite unidentifiable. Naturally in such a war as the present one, or in some phases of the one just mentioned, any search of the field, or any long examination of the bodies would be quite impossible, but, granting the opportunity, which does sometimes occur, even in the case cited by Bismarck, certain of the parts missing from the remains seen by him might be found on the field, and properly identified. It would even be possible, where all chance of studying such remains fails, to collect from bodies a given finger, perhaps the right thumb, and identify these far in the rear, where the opportunity to do so would be given. These positively identifiable parts, in an extremity, could be collected into vats of alcohol or formalin, for identification at some later time, even after the close of the war, when the legal importance of proving death would, in the case of some individuals, be of sufficient importance to far more than repay the small expenditure for this work.*

* While publishing this (July, 1917), the American army officials are working with the problem of the identification of soldiers, and are furnishing the men with identification tags of "Monel metal," which bears the imprint of the right index finger, etched into the metal by a process devised by Mr. J. H. Taylor, a government expert in the Bureau of Navigation. This is undoubtedly the most practical method in case of the need to identify an entire body, but if a record were made complete, and included as well the record of the palms and the soles, an identification could be made from a detached hand or foot. In this connection sole-print records would be of especial use, since a heavy leather shoe would often afford the necessary protection to a foot to allow a perfect and complete identification.

Another important use of such identification in the army and navy comes in the case of deserters, who attempt, after a time, to re-enlist; technically called "repeaters." Naturally, with the chance of enlisting anywhere in the country, a deserter who has once got successfully away has every chance in the world of re-enlisting somewhere else. With any system founded upon the never-changing friction skin, whether fingers or palms, or even soles, such a re-enlistment could be absolutely prevented, the question resting merely upon the amount of machinery involved, and the question of expediency. With one of the enormous armies of the present day, numbering one, two, or even four million men, constantly changing, the machinery for such a perfect identification would be extremely expensive, both in time and money, and would probably never be practical, yet, so far as the system is concerned, *it could be done.*

For this use in recording the individuals that make up an army, it is probable that the palms and soles would be of more practical benefit than finger prints. The characters dealt with are large enough to be inspected with the unaided eye, so that in many cases a single glance at a hand or foot would show non-correspondence, and thus avoid unnecessary delay. In the case of mutilated bodies, also, hands and feet would be very likely to be available, and, if the records were indexed for each of the four members, a single hand or foot could be at once traced.

A most important use of some form of friction-skin identification in the case of all enlisted men is to prevent the possibility of pension impersonators when the men in the present conflict become aged veterans and begin to die off. Pension frauds in connection with the Civil War are still so real a danger as to bring this point home to the authorities, and suggest the advisability of expending a small sum in identification now to avoid the loss of much larger amounts by fraud in a later time.

10. *To prevent Forgeries of Paintings or other Works of Art.* As compared with the larger interests here treated, this application is a very special one, and would have a restricted application; it is, however, no less important in the eyes of a connoisseur. As told in the recent press, "the idea emanates from Prof. Bordas, to whom it was suggested by noticing that in a landscape by Vollon the artist had accidentally left a finger print in the sky." Each artist could register his prints with the appropriate government authority, such as the Minister of Fine Arts in countries that have such an official, and surcharge some particularly characteristic piece of brush work, unessential to the painting, with a finger mark, done when the paint was wet. This would pretty effectually prevent forgery.

The same could be done with statuary in clay or terra cotta, and would reproduce fairly well in a bronze cast.

Conclusion. Finally, in order fully to employ the ample means furnished by nature for individual identification, there must needs be es-

tablished by each civilized nation a National Identification Bureau, which shall see to it that every individual in the nation be printed, and that the prints be kept in certain central stations, and there recorded and classified. A move in this direction could well be made by cities and large towns, independently of one another, each establishing and keeping a Municipal Bureau of its own until such a time as the country is ready for some form of co-operation, or organization. Aside from cities the rural communities could be controlled from the county seat.

Children could be printed on first entering school, as they are now vaccinated in many communities, the ordeal of printing being far less formidable, and without the after effects. Prints taken from young children are especially clear, and without the obscuring wrinkles of later life; and an intelligent co-operation may be usually secured from children as young as five or six years, or even earlier. Incidentally the prints are much smaller at that age, and easier to file, while there is no impairment of clearness.

This method of taking universal records, and thus providing for the exigencies of life in the direction of identification under all circumstances, was advocated by one of the authors as early as 1903,* and specifications were made at some length as to the size of room, the details of the office furniture required, and the probable amount of work entailed in properly caring for the prints of all the inhabitants of a city of 100,000. It was there stated (pp. 409–410): "Prints could be taken in each township or municipality, and filed away in any convenient spot, perhaps the court-house of each county seat. They could be taken in connection with the school registration, either when first entering, or better yet at the age of twelve to fifteen."

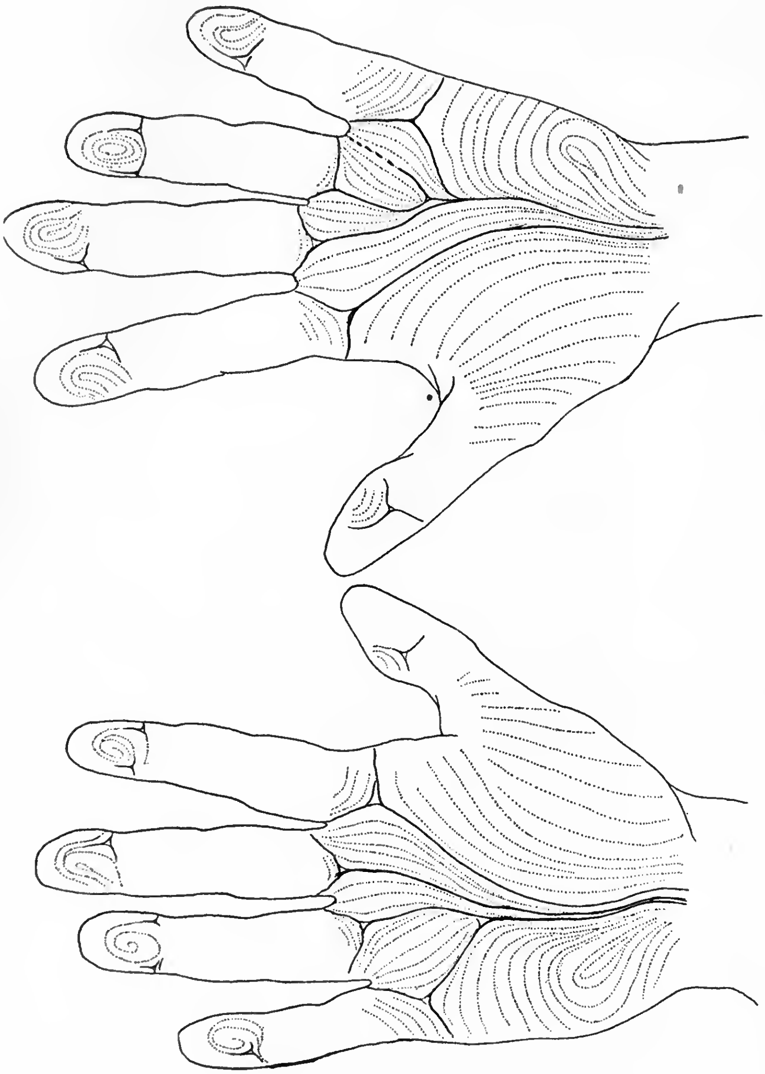
Among the uses of such a system, when once established, it was then suggested that "similar records could be taken by the various civil and religious institutions in which the identity of an individual is apt to be called in question. Banks could require an imprint of the left palm upon the inside cover of bank-books; business men could issue checks with a facsimile engraving of the palm of their own left hand covering the face; insurance companies could keep a palm and sole list of their clients; the Geary law would be rendered a certainty if the certificate issued to each Chinaman bore, besides the photograph, a single palm print, and churches could file away palm and sole prints among their baptismal records."

We can close this book in no better way than by placing here a quotation from Alphonse Bertillon, who, while establishing his system of identification by bodily measurements, clearly saw, perhaps for the first time in the world's history, the need of Universal Identification.

* *Popular Science Monthly*, September, 1903, pp. 385–410.

"To fix the human personality, to give to each human being a definite individuality, durable, unchangeable, always recognizable, and easily demonstrable; such seems the most comprehensible object of the new method." *

* ". . . fixer la personnalité humaine, donner à chaque être humain une identité, une individualité certaine, durable, invariable, toujours reconnaissable et facilement démontrable, tel semble l'objet le plus large de la méthode nouvelle." Instruc. signal. Introd. p. lxxxiii.



APPENDIX

OWING to the kindness of the publisher the authors are enabled to reproduce here the diagrams of a pair of hands which deviate from the usual human type so far as to closely resemble the arrangement found in the large man-like apes, especially, the chimpanzee. These are in the authors' experience absolutely unique, being totally unlike any in a collection of the palm prints of some 1100 individuals.

In the left hand all four of the Main Lines, instead of crossing the palm *transversely*, do so *longitudinally*, and terminate together at the wrist, giving the otherwise unheard-of formula, 1.1.1.1. In the right hand, however, a delta is found below the ring finger, into which Line C runs, so that, if we take the recurving radiant as its continuation, we get for Line C the value of 7, which makes the whole formula 1.7.1.1; yet, even here, if we take the lower radiant for the continuation of Line C, as is more natural, the line runs into B and D, and ends with them at the wrist, as in the other hand.

This longitudinal direction of the friction ridges of the palm, so rare in the human race, is the rule in the large apes, giving such formulæ as 3.3.2.1 (in a gorilla), or 7.6.2.2 (in a chimpanzee), these being understood to be the formulæ for individual apes, and not for all of the species.

Perhaps the most remarkable part of this entire incident is that in every other particular the young woman in question is a thoroughly refined, normal American white, a graduate of Smith College, and a more than average student. Furthermore, the hands themselves are perfectly normal in appearance; they are delicate and graceful, with nothing about them to suggest the possibility of a peculiar ridge configuration. The hands of both parents are quite usual, with the formulæ 11.7.7.4 and 11.9.7.5 for the father, and 11.9.7.5 and 11.11.9.5 for the mother. This last is a little unusual, but one quite to be expected in a white person.

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